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Combustion of Hazard Division 1.3 M1 Gun Propellant in a Reinforced Concrete Structure

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FOREWORD

This document presents the results of four tests conducted to address needs presented in the document, *Realistic Safe-Separation Distance Determination for Mass Fire Hazards* (Reference I-3). Reference I-3 presented results of an extensive literature review of accidents and incidents involving munitions. One of the major conclusions of the review is that the initial major reaction in over 80% of the accidents was fire.

Another major conclusion within the report is that the current weight-based approach for determining safe-separation distances for Hazard Division (HD)1.3 presented in the Department of Defense Manual (DODM), *Ammunition and Explosives Safety Standards* (Reference I-1) is inadequate for addressing the hazards from mass fire reactions of these materials. One of the major deficiencies is that burning energetic materials within robust structures such as reinforced concrete magazines can cause choked flow that, in turn, causes rapid pressure rise within the structure. This pressure can cause rupture of the structure within seconds after ignition of the energetic material with associated projection of structural debris to distances well in excess of the safe-separation distances (e.g., inhabited building distance [IBD]) called out in the standards mentioned above. Unfortunately, there was very limited data available to determine whether choked flow will occur and, if choked flow did occur, the likelihood and characterization of structure rupture and structural debris projection.

Projection of structural debris is not the only hazard associated with mass fire of HD1.3 materials. Because the rupture of the structure and projection of structural debris can occur very early in the burn before much of the energetic material has been reacted, the subsequent combustion of the remaining energetic material produces a large fireball that presents additional hazards. Fatalities can occur due to direct contact with the fireball as well as from radiation from the fireball if there is sufficient radiant heat flux and exposure time. Again, there is limited data available to predict the hazards associated with the fireball and determination of safe-separation distances.

The Department of Defense Explosives Safety Board (DDESB) recognized the need to better understand the hazards from mass fire reactions and provided funding for the highly instrumented tests, reduction and interpretation of the data, discussion of results, and recommendations presented in this document.

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14. ABSTRACT
(U) This document describes the results of four tests involving the combustion of M1 gun propellant, an HD1.3 material, burning in a reinforced concrete structure. Chapter I presents an overview of the four tests, major test results, discussion, summary, conclusions, and recommendations. Chapters II through V present a detailed discussion of each test by chapter. Chapter VI presents a summary of the modeling effort that supported the study. Some major findings include the following. (1) If the flow from the structure is unchoked (Tests 1 and 3), the pressure in the structure remains on the order of 1 to 2 psi, and the structure survives. The major hazard is the hot plume exiting the structure and radiation from the plume. (2) If the flow from the structure is choked (Tests 2 and 4), the pressure in the structure rises until the structure fails. The pressures at rupture were 47 and 34 psi for Tests 2 and 4, respectively, at 1.4 and 2.3 seconds. (3) Structural debris was formed at rupture and projected significant distance from the original structure. Some debris were large, exceeding 1,000 g (largest fragment was 11,555 g), and were projected over 400 feet. The projected distances of many fragments exceeded the inhabited building safe-separation distances. A huge fireball was formed and burned intensely for about 15 seconds. Direct impingement of the fireball and radiation are hazards that must also be considered in addition to the formation of structural debris.

15. SUBJECT TERMS
Choked Flow, Department of Defense Explosives Safety Board, Hazard Division, Loading Density, M1 Gun Propellant, Safe-Separation Distances, Vent Area Ratio

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NOMENCLATURE

1P	single perforation
7P	seven perforations
c^3	cubic centimeter
CFD	computational fluid dynamics
cm	centimeter
DBT	dibutylphthalate
DDESB	Department of Defense Explosives Safety Board
DDT	deflagration to detonation transition
DFT	directional flame thermometers
DNT	dinitrotoluene
DODM	Department of Defense Manual
dp/dt	pressurization rate
DPA	diphenylamine
ESS	Explosive Safety Siting
FCOS	from center of original structure
FLIR	forward-looking infrared
g	grams
GPS	Global Positioning System
HD	hazard division
IBD	inhabited building distance
ILD	intraline distance
IM	insensitive munitions
IMD	inter-magazine distance
IR	infrared
IRIG	Inter-range Instrumentation Group
kg	kilograms
KSC	Kennedy Space Center

m	meter
m/s	meters per second
mm	millimeter
MPa	megapascal
MSM	modular storage magazine
NASA	National Aeronautics and Space Administration
NAVFAC EXWC	Naval Facilities Engineering Command Engineering and Expeditionary Warfare Center
NAWCWD	Naval Air Warfare Center Weapons Division
NEW	net explosive weight
PO	outside pressure
psi	pounds per square inch
PTRD	public traffic route distance
QD	quantity distance
SAFER	safety assessment for explosive risk
TC	thermocouple
VAB	vehicle assembly building

CHAPTER I. AN OVERVIEW OF TESTS 1 THROUGH 4

INTRODUCTION

Significant work has been performed in the past 50 years to obtain quantity-distance requirements for hazard division (HD)1.1 materials. This work has provided the current weight-based siting criteria, where the distance (d) is equal to the safety weighted factor (k) times the cube root of the explosive weight ($d=kW^{1/3}$). The k values are typically generated by detonating various quantities of HD1.1 explosive donor to determine the effects generated by the donor and the acceptable levels of hazard posed to various acceptors based on their respective reaction to the donor's effects. The Department of Defense Manual (DODM) 6055.09-M defines the siting criteria (Reference I-1).

Current siting methodologies for energetic items other than HD1.1 may not be adequate. There is a push to produce safer munitions with hazard classifications of less than HD1.1. Traditionally, HD1.1 materials are shock sensitive versus the thermally sensitive HD1.3 and HD1.4 materials (Reference I-2). Reference I-3 includes a section that discusses why current weight-based siting methods are inadequate for determining safe-separation distances from mass fire HD1.3, followed by sections advocating determination of safe-separation distances based on human response to mass fire.

This document describes the results of four tests involving the combustion of M1 gun propellant, an HD1.3 material, burning in a reinforced concrete structure. The first test was a scoping test to check out the test plan, the ignition system, and the instrumentation. This test and the subsequent tests are described in Chapters II through V of this document. Chapter VI presents an overview of the modeling that supported this effort.

This work was performed to address needs identified in a previous project funded by the Department of Defense Explosives Safety Board (DDESB) and presented in the document *Realistic Safe-Separation Distance Determination for Mass Fire Hazards* (Reference I-3). Reference I-3 includes results of an extensive literature review of accidents and incidents involving munitions. One of the major conclusions of the review was that the first major reaction in over 80% of the accidents was fire. These fires may then be followed by an explosion or a detonation. This explosion/detonation reaction may have been caused by the confinement of the energetic and the pressure increase as a result of the burning energetic.

Reference I-3 also presented outcomes that showed that combustion of munitions and energetic materials such as bulk propellant burning in a robust structure (i.e., reinforced concrete magazines) producing a rapid pressure increase in the magazine

can produce hazardous effects other than thermal hazards. The result of this bulk propellant burn was a rupture of the structure and projection of debris significant distances beyond the original structure (Reference I-4 and I-5). The rupture occurred seconds after the ignition of the material. Unfortunately, there was very limited data to use for the prediction of the likelihood and characterization of structure rupture and structural debris projection. The overall objectives of this effort are as follows:

(1) Understand safe-separation criteria as pertaining to HD1.3 munitions

   a. Quantify how increased loading density (the weight of energetic material in the structure divided by the volume of the structure) of ammunition and explosives results in changes to structural response (low pressure resulting in no damage to the structure versus rapid pressurization within the structure resulting in rupture of the structure with projection of structural debris (fragmentation patterns/distances)).

   b. Quantify fireball dimensions and the distance of propellant ejection from the structure.

   c. Quantify the pressure rupture of the structure when choked flow occurs.

   d. Determine the influence of structural design and venting on HD1.3 munitions (frangible doors, vents, etc.).

(2) Develop a better understanding of rupture of structure and propagation of structural debris due to rapid pressurization within the structure versus detonation type reactions for the purpose of improving quantity-distance criteria for HD1.3 materials.

(3) Compare/validate predictions of the structure pressurization, fragmentation, and fragment throw distance from current models.

BACKGROUND

Three main test programs have been performed looking at the hazards of HD1.3 items burning in structures. These studies were performed by W.R. Herrera, et al. (Reference I-6); C.E. Joachim (Reference I-4); and L. Allain (Reference I-5). The Herrera tests were performed with gun powder in an igloo structure at low loading densities and with a large vent area to allow for venting of the combustion gases so that pressure did not build up in the structure (referred to here as unchoked). The structure was used over and over again since it did not fail. Joachim's test series used M1 gun propellant with higher loading densities than Herrera. The vent size was held constant with an opening 35.6 cm in diameter. The flow was unchoked in the first three tests (loading densities below 0.02 g/cm^3), and the pressure inside the structure was low. The final test with a loading density of 0.05 g/cm^3allowed pressure to rapidly increase in the structure causing structural failure in 5.3 seconds after ignition (referred to here as

choked). Allain's studies were with 1/3-scale earth covered magazines with a propellant having a composition very similar to M1. The importance of confinement was shown in this series with two of the structures lifting off the ground allowing combustion gas to exit. One of the structures lifted approximately 1 meter off of the ground. The entire structure was secured to the ground in subsequent tests, and the structure ruptured in Tests 3 and 4. Test 4 was conducted using a steel lined concrete structure. The structure ruptured 1 second after propellant ignition and produced 5 main concrete and 5 main steel fragments with the roof and each wall relatively intact. The farthest fragments were found approximately 24 meters from the structure. The maximum pressure in the structure prior to failure was measured as less than 1 MPa (145 psi).

Propellant was ejected from the structure and burned outside the structure in the unchoked flow condition. A large fireball occurred when the structure ruptured in the choked flow condition. The thermal-flux level and its duration are important and must be considered when determining the thermal hazard in both unchoked and choked flow conditions.

The pressurization of a structure is a competition between the pressurization produced from reacting the solid energetic material to product gases and the release of pressure by gases leaving the structure through venting. The pressurization due to reaction from solid energetic material to product gases is dependent on the density of the solid, the surface regression rate of the solid (often called the linear burning rate), the burning surface area, and the thermochemistry of the reaction. Because gun propellants have high surface area available for combustion, they produce rapid pressurization. Choked flow occurs when the pressure inside a vessel or structure is about twice that of the pressure outside the structure. Once the flow is choked, pressure inside the structure can increase quite rapidly as the energetic material burns inside the structure.

A term often used in describing venting is *vent area ratio.* This non-dimensional quantity is simply the vent area divided by the chamber volume to the 2/3 power. Another term often used is the *loading density* of energetic material defined earlier as the weight of energetic material divided by the volume of the structure. A high vent area ratio and a relatively low loading density are needed for a structure to survive. Reference I-3 presented a plot of these quantities for several tests described in the literature with some of the tests having choked flow, resulting in rupture of the structure and several where the structure survived due to unchoked flow. The plot from Reference I-3 is reproduced below in Figure I-1.

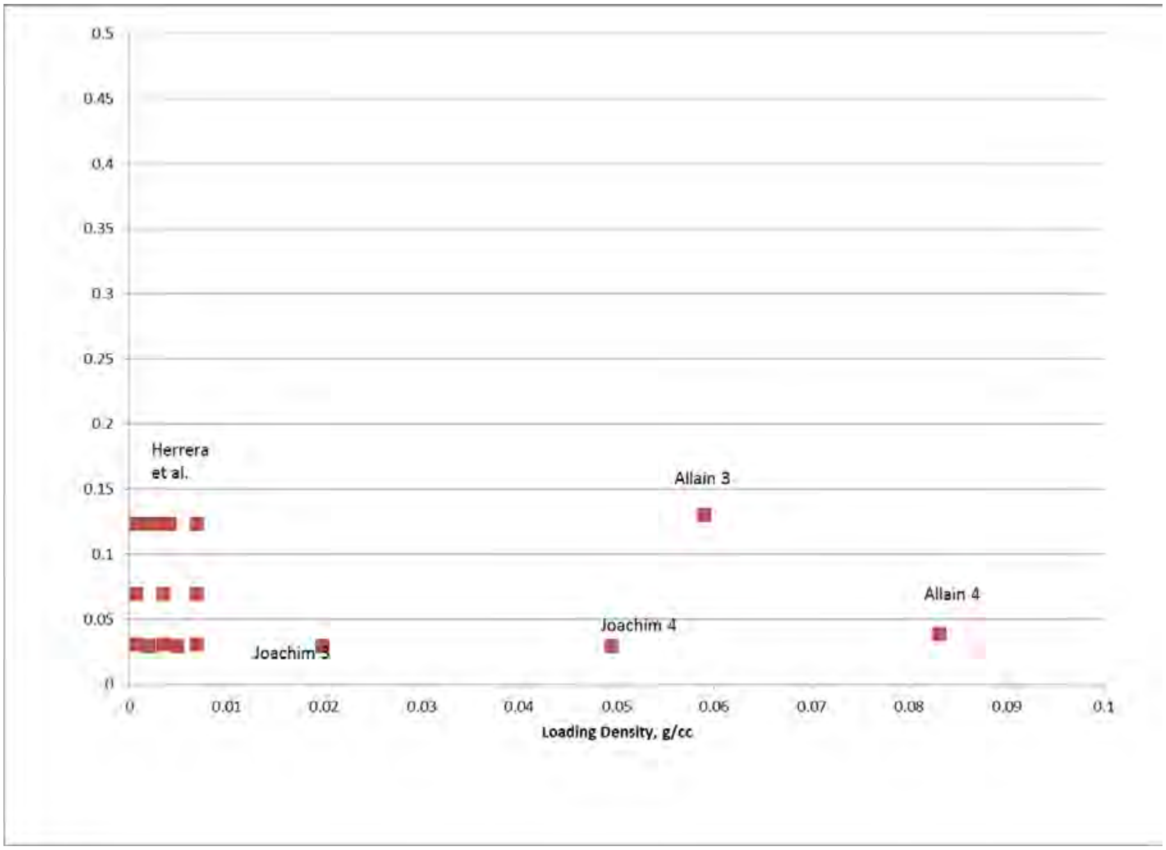


FIGURE I-1. Plot of Loading Density Versus Area Ratio for Tests (Reproduced from Reference I-3).

The tests at loading density of 0.02 g/cm^3 or less (Joachim Test 3, and all of the tests to the left, including all of the tests performed by Herrera et al. [Reference I-6] and Joachim Tests 1 through 3 [Reference I-4]) had unchoked flow, and the structures were undamaged and used again. In contrast, the tests with loading density 0.05 g/cm^3 and higher (Joachim Test 4 and Allain [Reference I-5]) were all choked flow, and the structure was destroyed. Note should be taken that Allain Tests 1 and 2 were not secured to the ground; when the gun propellant was ignited, pressure built up very rapidly causing the structures to rise up off the ground and allowing combustion products to vent relieving internal pressure. Allain Tests 1 and 2 were omitted from the plot due to the unknown vent area ratio.

Addressing the question of unchoked flow (no rupture) or choked flow (rupture with projection of structural debris) is only a partial consideration of the hazards associated with HD1.3 energetic materials. The hazards from the plume exiting the structure for unchoked flow, and the fireball following rupture of the structure for choked flow, still need to be addressed. If a person is directly in the plume or fireball, they will quickly become a fatality due to the high temperatures and often toxic vapors. Even if a person is not directly in the plume or fireball, the radiation hazard in terms of heat flux and exposure time may still result in fatalities. DODM 6055.09 (Reference I-1) has recently

been modified to include prevention of second-degree burns using exposure times less than the time given by the following equation:

$$t = 200\ q^{-1.46}$$

where

q = heat flux, kW/m^2

t = exposure time, seconds

For example, a flux of 10 kW/m^2 will result in second-degree burns at 6.9 seconds exposure time, while a heat flux of 15 kW/m^2 will cause second-degree burns at 3.8 seconds exposure time. A flux of 5 kW/m^2 gives 19.1 seconds before the onset of second-degree burns, giving a modest amount of time to recognize the threat and take evasive action. The petroleum industry uses a criterion of 5 kW/m^2 at the boundary fence as one of their safety criterion for fire in refineries (Reference I-7). Fortunately, the heat flux diminishes roughly as 1/d^2 with d being the distance from the plume or fireball.

Models were designed or modified using current software to determine if a predictive capability existed for understanding the thermal behavior of the propellant and effects of internal pressurization on the structure and its mode of failure. High fidelity physic-based analysis software was used to explore both the propellant behavior and the structural behavior. These models were then used to predict the response of the structure for current tests and future testing. Current siting tools found in TP-14 and DOD 6055.09 were also used to compare the current siting criteria to the fragment pattern found in Tests 2 and 4. Fast running models were run to determine if they could be used to improve the siting criteria, to determine debris throw, and thermal hazards for HD1.3 materials.

TEST PLAN

Four tests were performed in this study to assess how loading density and influence of venting impact the hazards associated with burning HD1.3 materials inside a reinforced concrete test structure. The HD1.3 category is very broad (Reference I-8). An HD1.3 gun propellant was used in this study since gun propellant has significant surface area and leads to rapid pressurization of the structure, potentially causing a “worst case” structural breakup without items going propulsive. The gun propellant M1 was chosen to allow comparisons between this study and previous studies. It is recognized, however, that this test would not be a “worst case” scenario due to the low potential energy of M1 compared to other gun propellants. The M1 gun propellant was easily accessible from the demilitarization account in the quantities required for this test series. The test conditions of this study were selected based on the data of Joachim and Allain (Figure I-1) and their use of M1 gun propellant or a similar formulation.

All four tests used a Kasun-type structure. The Kasun structure was used in a series of experiments in Sweden where different loading densities and cased/uncased munitions of HD1.1 were tested (Reference I-9). The goal of using the same structure was to compare the response of the HD1.1 reaction at varying loading densities to the HD1.3 tests. The idea was to compare the fragmentation and distance of fragment throw between the two test series. These tests would also provide the opportunity to assess the limitations of the current HD1.3 siting methodology.

SAMPLE

M1 gun propellant was the energetic material used in Tests 1 through 4. The propellant samples were obtained from Hawthorne, Nevada, from the demilitarization account. The composition of M1 propellant is given in Table I-1.

TABLE I-1. Composition of M1 Propellant.

Ingredient	Weight %
Nitrocellulose	85.00 ± 2.00
Dinitrotoluene (DNT)	10.00 ± 2.00
Dibutylphthalate (DBT)	5.00 ± 1.00
Diphenylamine (DPA)	1.00 ± 0.10
Lead carbonate	1.00 ±0.20
Potassium sulfate	1.00 ±0.30

M1 propellant comes in many configurations. The configuration used in Tests 1 and 2 was small cylinders of propellant having a single perforation in the center (1P). The nominal dimensions were a 1.22-mm outer diameter, a 5.03-mm length, and a 0.514-m perforation diameter (Figures I-2 and I-3).

FIGURE I-2. End View of M1 Gun Propellant Grains Used in Tests 1 and 2.

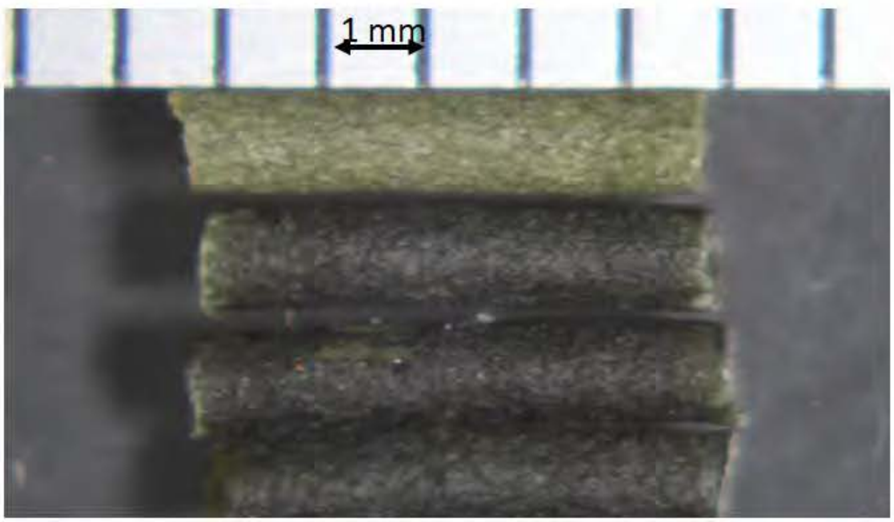


FIGURE I-3. Side View of Propellant M1 Gun Propellant Grains.

Tests 3 and 4 used larger propellant grains with seven small perforations in each grain (7P). The nominal dimensions were a 4.77-mm outer diameter, a 10.765-mm length, and 0.451-mm perforation diameters (Figure I-4).

Combustion of the smaller geometry grain produces a higher pressurization rate than the larger 7P grain, as illustrated in the pressurization rate (dp/dt) versus time plot in Figure I-5 for the two propellant geometries from closed bomb firings at equivalent loading density (mass burned per unit volume). This difference in burning characteristic was reflected in the time to reaction and internal pressurization of the burning in the structure for Tests 2 and 4.

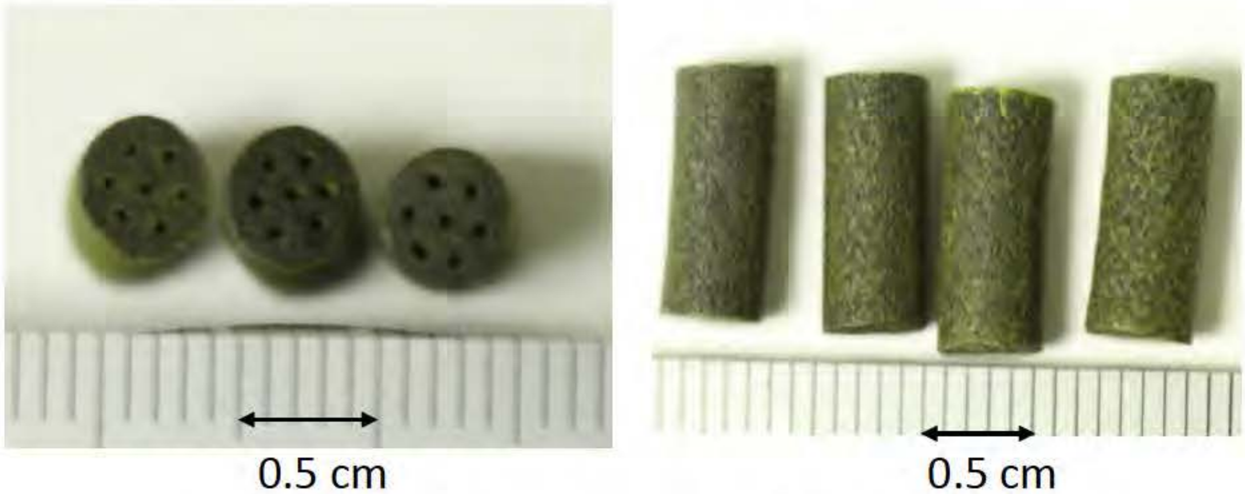


FIGURE I-4. M1 Propellant Grains Used in Tests 3 and 4.

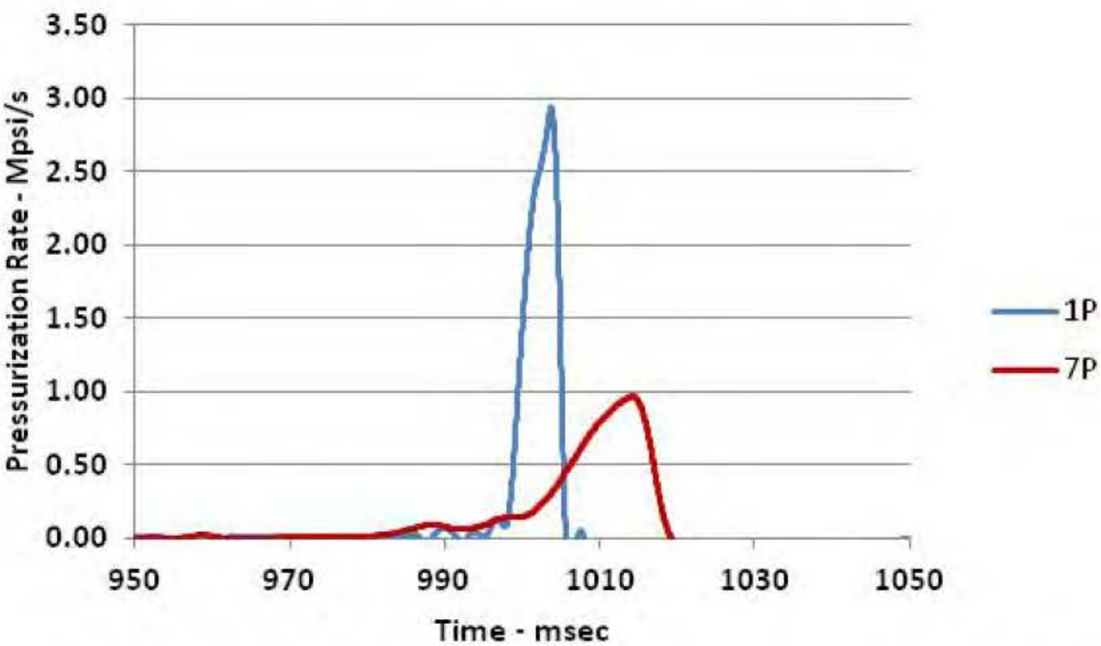


FIGURE I-5. Pressurization Rate Versus Time for Two M1 Propellant Geometries.

Fiber drums (19.5 inches in diameter and 26.5 inches high with lid) containing the M1 propellant were placed in the test structure (Figure I-6). The loading density of the propellant in the structure, total weight, and number of barrels used in each of the tests is given in Table I-2. The number of barrels was consistent between the unchoked tests (Tests 1 and 3) and the choked tests (Tests 2 and 4); however, the amount of material in each barrel and the height of the propellant in the barrel varied from test to test.

Point-source igniters were placed in each of the drums of gun propellant. The drums were simultaneously ignited with an electric match firing into 0.25 pound of smokeless powder as ignition aid.

FIGURE I-6. Three Drums of M1 Propellant
Placed Within the Structure for Test 1.

TABLE I-2. M1 Propellant Loading.

Test #	Grain Type	Weight, kg (lbs)	Loading Density, kg/m^3	Drums
1	1P	135 (296)	16.78	3
2	1P	535 (1,176)	66.68	8
3	7P	120 (264)	15.00	3
4	7P	503 (1,108)	62.88	8

The authors used a numerical model, NWCDDT, developed previously at China Lake, to evaluate the likelihood of a DDT (References VI-10 and VI-11). The NAWCWD Combustion Sciences Branch personnel used the model to simulate the combustion of a tube packed with M1 in a one-dimensional manner, with a two-dimensional treatment of the tube and its failure. All calculations performed with the NWCDDT model resulted in non-DDT events. The model validates the assumption that M1 propellant will not undergo a DDT event in the test configurations.

TEST STRUCTURE

The test firings were made with a structure similar to the Kasun structure of Reference I-8. The Kasun structure documentation for the Swedish test series provided dimensions of the structure, type of rebar, and concrete strength. Full drawings were constructed based on their description. The drawings were sent to the contractor for construction and can be found in Appendix I-A. The test structure was built of reinforced concrete having inside dimensions of 2 m by 2 m by 2 m and an internal volume of 8 m^3. The walls were 15.2 cm (6 inches) thick. The concrete mix ratios and strength data for the test structures are given in Appendix I-B. The test structure is shown in Figure I-7. The outside of the structure was painted with a grid pattern using white and black paint to provide a measure of deformation of the structure should failure occur. The structure contained two small openings to allow for pass through of the internal instrumentation lines and firing line. These openings were sealed with Great Stuff™ Fireblock Insulating Foam Sealant prior to test initiation.

FIGURE I-7. Test Structure With Plate Having a
79-cm Orifice Bolted Into Place.

The concrete in the walls and ceiling of the structure were color coded as follows: the ceiling (black), the back south-facing wall (red), the east-facing wall (yellow), the north-facing wall (gray), and the west-facing wall (green) to help determine the source of the fragments. Figure I-8 shows a photograph of the color-coded concrete walls. The floor was also gray, as it was assumed that it would not fragment.

FIGURE I-8. Color Coded Concrete Walls.
Black = roof, red = south wall,
yellow = east wall, and green = west wall.

The north wall had a 0.91-m by 1.52-m (3- by 5-foot) door opening. The door frame was a U-shape of quarter-inch-thick steel into which the concrete of the north walls was cast and had sixteen 1.5-inch-diameter (3.8-cm) grade-5 bolts through the frame (structural drawings included in Appendix I-A). Note should be taken that the door frame was only connected to the rebar at the top and bottom of the structure as will be seen in the post-test photos of Tests 2 and 4. A 1.5-inch-thick (3.8-cm) steel plate with an orifice was placed over the bolts as a closure. The closure was secured with hardened, high-strength washers and grade-5 nuts (Figure I-7).

The orifice in the closure plates was varied with Tests 1 and 3 having a 79-cm-diameter orifice (31.1 inch), and Tests 2 and 4 a 39-cm-diameter (15.4 inch) orifice. The larger orifice for Tests 1 and 3 was chosen to ensure that the flow from the chamber would be unchoked, and that there would be minimal pressure rise inside the chamber, representing a well-ventilated structure. The smaller diameter opening for Tests 2 and 4 was chosen, because it resulted in choked flow as might be seen in a rigid structure with minimal venting. The choked flow condition caused pressure to rise inside the structure to multiple atmospheres, resulting in a pressure rupture of the structure. The test structures did not fail in Tests 1 and 3 allowing for reuse in Tests 2 and 4, respectively.

Tests 1 through 4 were performed at the Airport Lake (dry lake bed) test site of Naval Air Warfare Center Weapons Division (NAWCWD), China Lake, California. The test structure was placed with the closure plate facing the north direction. The structure sat on a wooden platform.

INSTRUMENTATION

A mixture of real time, high-speed, and infrared (IR) video along with temperature, heat flux, pressure measurements, Doppler radar, break wire, and fragmentation collection was used in Tests 1 through 4 to understand the hazards associated with thermal events and to provide data that could be used by the modelers to validate their model. Multiple forms of instrumentation were used to improve the fidelity of the data captured during the test. High-speed video and real-time video were employed in an effort to quantify the response of the propellant as it burned in the structure and overall environment. Likewise, the authors used the infrared video, temperature, and heat flux measurements to quantify the temperature distribution inside and outside the structure. Surveillance cameras and break wires were used in the structure to determine the flame spread rate of the propellant and to assess how the fire might propagate inside the structure. Doppler radar and high-speed video were employed to determine the velocity of the fragments/plume as a result of the propellant burning in the structure. A 360 degree fragmentation map noting color, size, and location for each fragment from the structure was generated following the failure of the structure.

Multiple data collection systems were used in this test series. The surveillance cameras were recorded on DVD recorders that were located approximately 100 feet from the structure in a metal berm to protect them from fragmentation. The video camera feeds were recorded at the Range Control Center. High-speed video, IR video, and Doppler radar were recorded locally on laptops after the test. The acquisition rates of the high-speed video and IR data were varied depending on the test. Three data collection systems were used to record the break wire, pressure, thermocouple, and heat flux data in this test series. The data collection systems were located 1,000 feet from the structure. As a result of the distance from the instrumentation, thermocouple amplifiers were used to convert the millivolt signal to volt so that the temperature and heat flux values could be recorded. Two Nicolet Vision data acquisition systems were used to collect the heat flux data. The Vision systems recorded at a rate of 1,000 samples per second. The HBM Liberty data acquisition system recorded the pressure, temperature, break wire, and remaining heat flux data. Data collection on the Liberty was varied based on whether the test was choked (20,000 samples per second) or unchoked flow (1 or 1,000 samples per second). The video and Doppler radar were triggered off the fire pulse used to initiate the M1 gun propellant. The Vision and Liberty systems used a pickle switch that was pressed once the fire command was provided. Inter-range instrumentation group time codes (IRIG) were used to synchronize the time for the various instrumentation suites

that were used during the test. There is some variability in the time data, since not everything was triggered on a single pulse.

Six piezoelectric pressure gages manufactured by Kulite were mounted inside the structure. Five of the pressure gages were mounted into an electrical box, as seen in Figure I-9, which was insulted to delay/prevent the thermal drift that would occur due to the propellant burning. During the first two tests, the pressure gages were mounted into the front plate. However, the gages melted in this position. In the final two tests, the gages were mounted into the side of the electrical box so that the transverse wave as it passed by the electrical box was measured. The five pressure gages were located in the center of the roof, floor, south, west, and east walls inside the structure to measure the pressure generated during the event. A sixth "stunt" gage was placed next to the pressure gage in an electrical box on the south wall in the structure to examine the drift occurring due to the thermal effects inside the structure. The pressure gages were employed not only to assess the pressure inside the structure but also to determine if the pressure generated inside the structure was uniform or if a particular wall saw an increased loading, thus causing a specific area to fail sooner. Use of the pressure-time histories collected from Tests 2 and 4 helped determine the type and magnitude of the loads applied to the walls of the structure in the models.

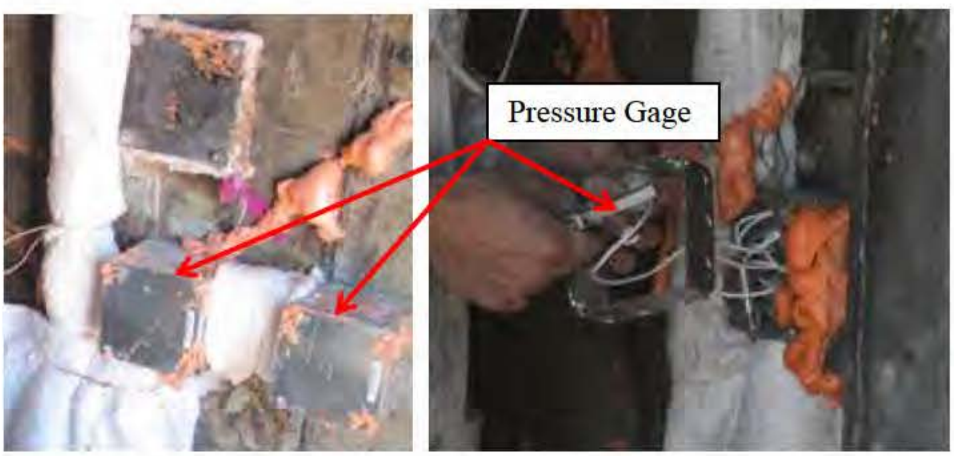


FIGURE I-9. Pressure Gage Mounted Inside Structure.

Twenty type-K thermocouples were placed throughout the interior of the structure to measure the temperature variation. Type-K thermocouples were used due to the large temperature variation that was expected during the experiment. Two types of thermocouples were used: beaded wire and probe (stick) thermocouples (Figure I-10). The differences between the two are minimal. The probe thermocouples contain a thin inconel sheath around the welded tip; the beaded thermocouple is just the welded tip without any covering (sheathing). The beaded wire thermocouples were used where surface temperatures were required, and stick thermocouples were used where air/open-flame temperatures were needed. A thermal probe was placed in each corner of the structure and in the center of the north wall near the roof and the floor.

Four thermocouples were positioned on the west wall to determine the temperature profile of the wall as well as to determine if the temperature may change the response of the concrete. The roof, floor, and south wall's pressure-gage boxes had thermocouples attached to the outside of the box to determine the temperatures that the pressure gages were exposed to. Three thermocouples were also located in the center of the structure attached to the fiber board drums in which the propellant was stored.

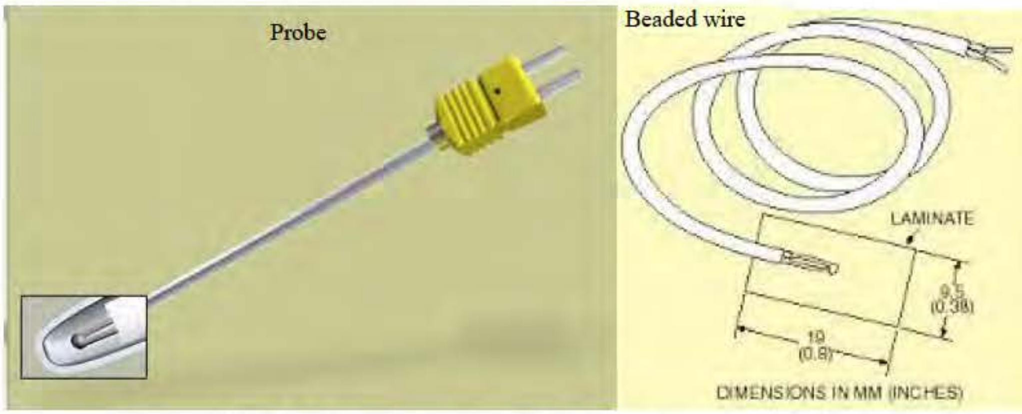


FIGURE I-10. Thermocouple Schematic (Beaded Wire and Probe) (Reference I-10).

Two Directional Flame Thermometers (DFT), manufactured by KTEC, were placed on the east and west walls as close to the center of the wall as possible to measure the thermal flux of the propellant fire inside the structure. Four types of heat flux gages were considered, the Gardon gage, Schmidt-Boelter gage, plate thermometer, and DFT. The DFT gage was employed due to the ability to provide a total heat flux measurement. This gage did not require water cooling, was of robust design, and was available for testing. However, the DFT design was recognized to have a slower response rate compared to the Gardon gage or Schmidt-Boelter gage. The DFT consists of two inconel plates with ceramic fiber insulation placed in between the plates. A thermocouple is welded to the back of each inconel plate as seen in Figure I-11. The temperature histories from the thermocouples allow for the calculation of heat flux (Reference I-11).

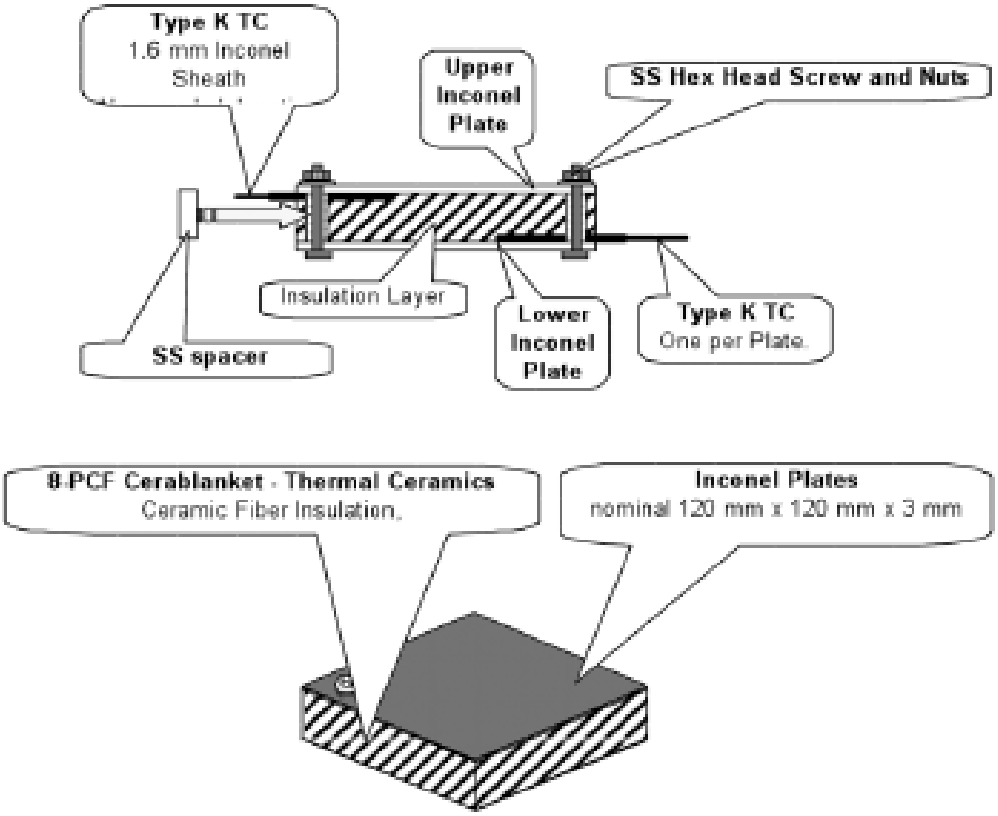


FIGURE I-11. DFT Schematic (Reference I-11).

Typical inside structure instrumentation placement is shown in Figure I-12. Gage identification numbers, pressure ranges, and their exact location in the structure can be found in the individual test chapters. Two overview surveillance cameras used for Test 1 were placed in the corners of the west wall positioned so that they would record the ignition and the burning of the propellant. In Test 2, one camera was placed on the floor in the northwest corner and then abandoned in the remaining tests since they were ineffective. Figure I-13 shows how the surveillance camera was protected from the heat. Break-wire was positioned at the bottom of two of the propellant barrels to obtain a mass regression rate of the propellant burning.

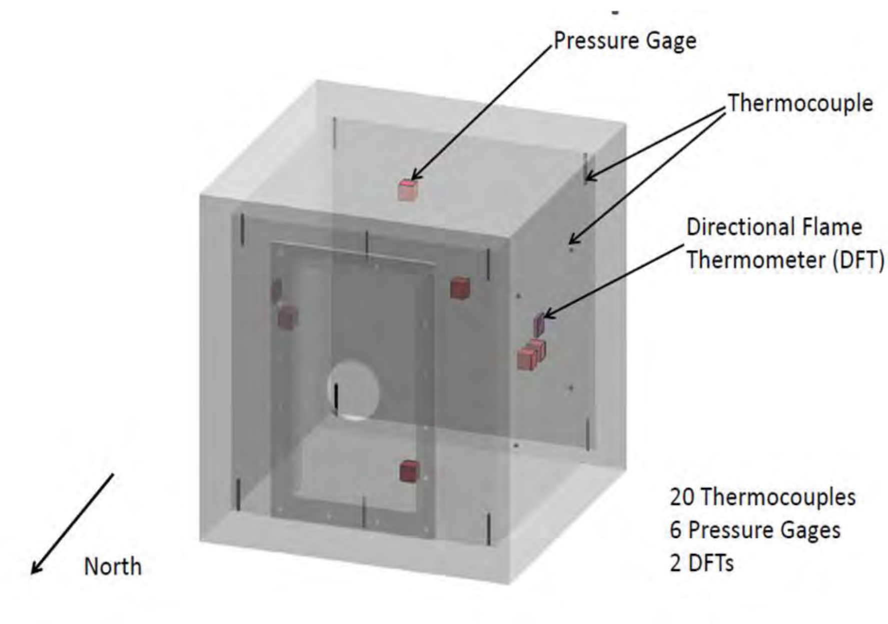


FIGURE I-12. Schematic of the Inside Structure Instrumentation.

FIGURE I-13. Surveillance Camera From Test 2.

The outside instrumentation consisted of DFTs, pressure gages, IR video, high-speed motion picture cameras, regular video, and Doppler radar. A schematic of the outside instrumentation is given in Figures I-14 and I-15. The designation PO refers to outside pressure transducers, and the DFT designation refers to the directional flame thermometers. Exact gage locations for Tests 1 through 4 can be found in Appendix I-C.

Eleven pressure gages were located outside the structure to determine if a detonation or an explosion occurred. Three gages were positioned at about 30, 60, and 164 feet on the centerline located approximately 5 feet in the air. These pressure gages would be exposed to a transverse wave, since they were positioned orthogonal to the structure. The remaining 8 pressure gages were located either 50 or 82 feet away from the centerline at 15 and 30 feet from the front of the structure. These pressure gages were pointed at the structure to measure the incident pressure wave.

Fifteen heat flux gages were used to quantify the size and lethal radius, as well as to validate the thermal model prediction of the plume. Heat flux gages were nominally placed at 15, 30, 60, 164, and 325 feet on the centerline; at the 50 and 82 feet locations on either side of the 15- and 30-feet center locations; and 50 feet on either side of the 60-feet center location. These gages were pointed to the door of the structure. It was expected that DFT 13 would see the greatest heat flux, since this gage would be most likely in the plume that was generated by the propellant burning.

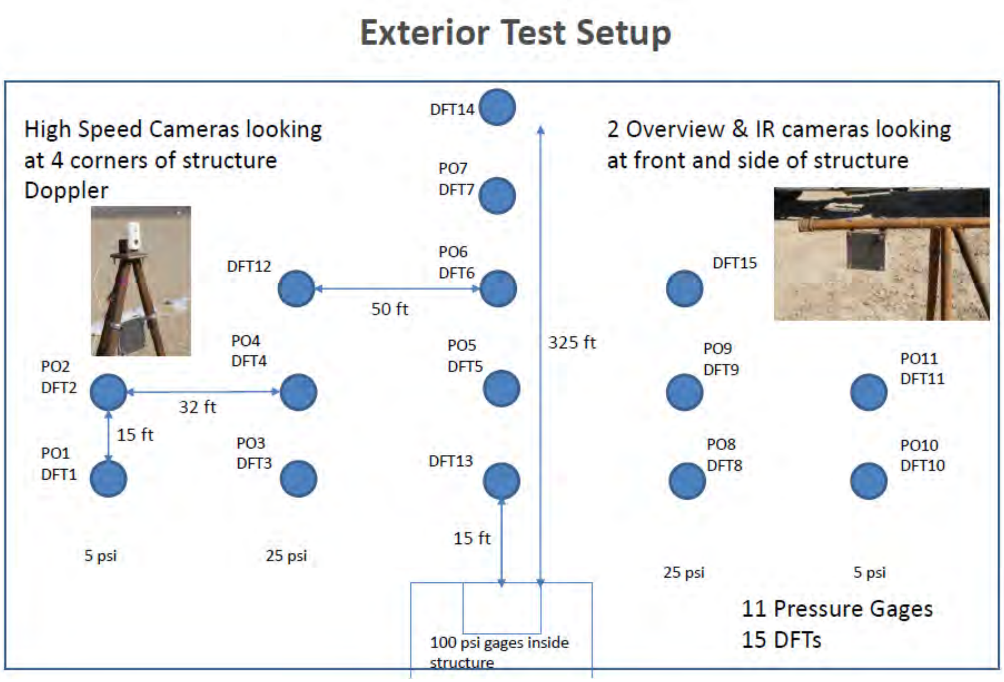


FIGURE I-14. Schematic of External Instrumentation Consisting of Pressure Transducers and Heat Flux Gages.

Camera locations are shown in Figure I-15 and were used to quantify the reaction of the structure, plume size, temperature and formation, and overall velocity of fragments if the structure fragmented. Two video cameras were used in the test series. One was used as an overall video of the test and also acted as a safety camera during testing and was positioned to look at the south wall. The second camera was used to provide an overview of the structure to document the plume formation and the response of the structure. The second video camera was located next to the high-speed camera located at 1,000 feet from the structure on the east side. Two IR cameras were used to document the size/temperatures of the plume. They were located orthogonal to each other with one facing the door while the other one had a field of view of the entire structure and as wide as possible in front of the door. Ultimately, these cameras were not calibrated properly and could not accurately measure temperatures seen in the test series. Four high-speed cameras viewed each corner of the structure for Test 1, but were relocated to orthogonally view the four walls for the remaining tests to better view the plume and fireball formation. High-speed video viewed the door area, overall structure, and locations to assess velocity of fragments as the structure came apart. Four poles were used as fiducials as shown in Figure I-16 to assist in the quantification of the velocity of the fragments. The velocity of the fragments can be determined by manually post processing the high-speed video to track the fragments. Currently, this process cannot be automated successfully so it requires a significant amount of time to do. All of the cameras were located at a distance of 1,000 feet from the test structure.

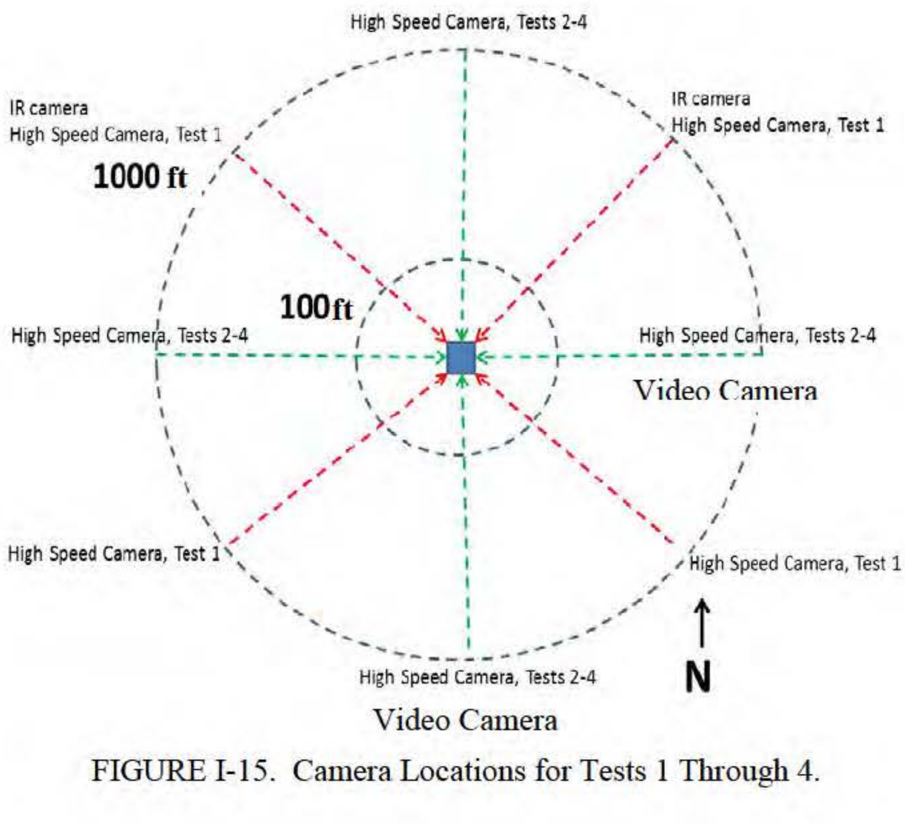


FIGURE I-15. Camera Locations for Tests 1 Through 4.

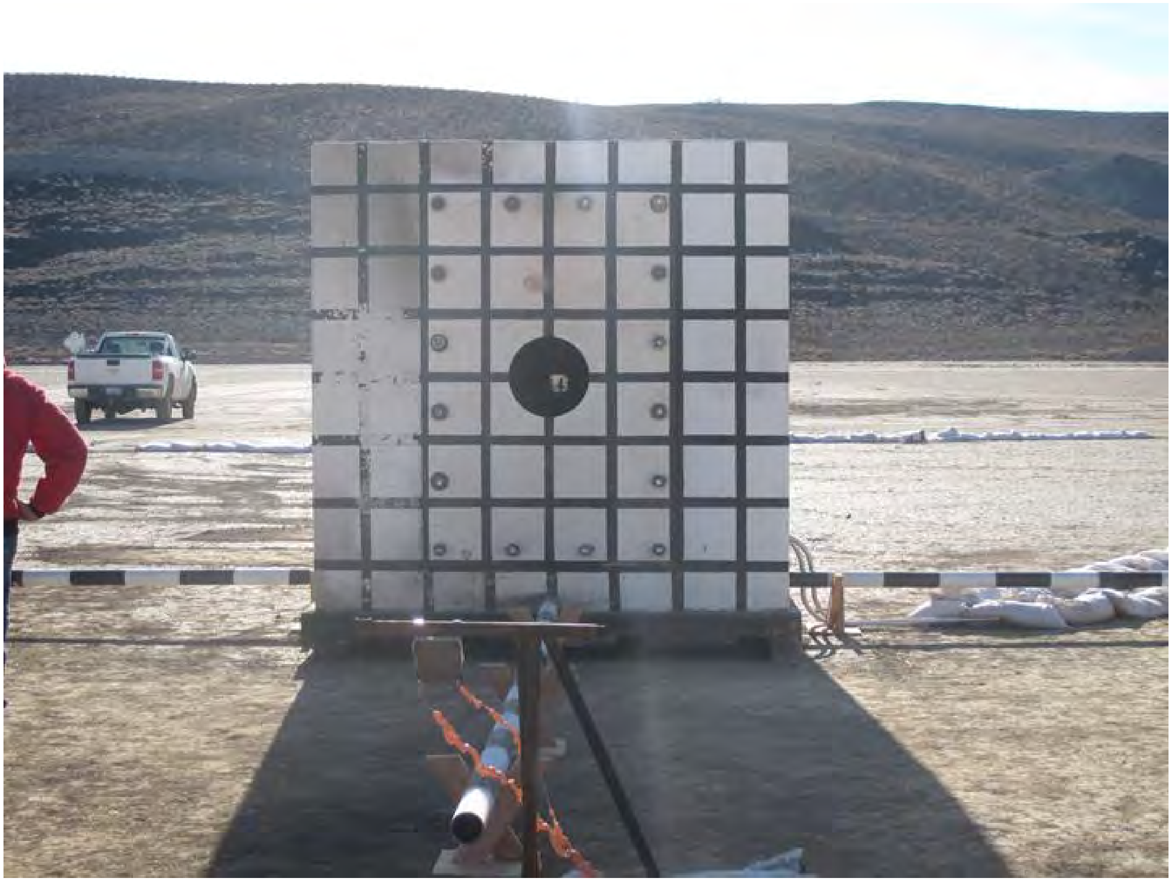


FIGURE I-16. Exterior of Kasun Structure.

Digital, still photographs were made to record the pretest setup and post-test remains. An overall picture of ground zero and the surrounding location was taken for each test. Photographs were taken of test item remains, debris, and cratering (if applicable) in such a way as to allow determination of size (e.g., use of a scale or rule).

Doppler radar was used to evaluate plume and fragment velocity. Doppler radar was being used in an attempt to reduce the amount of post processing required to determine fragment velocity from the high-speed cameras. The Doppler radar has the capability to track multiple fragments going away or at the radar. This would allow a quicker determination of fragment velocity. The Doppler radar was located approximately 1,080 m from the structure at an angle so that the entire structure and plume was visible. The Doppler data was moderately successful in that it was able to track the plume and provided a plume velocity; however, the fragmentation aspect was not as successful, since it appeared to the radar that the fragments went up and not toward or away from the radar in Test 2 and only tracked the fastest fragment in Test 4. Other Doppler radars exist that might be more appropriate for this application.

Fragment mapping was performed in Tests 2 and 4 where structure failure occurred. The source of the recovered debris was identified and associated with a component of the

structure during the cataloging process. The area around the burned out structure, beginning at 15 feet from its center was completely searched for debris. The following data were taken for each piece of debris weighing more than 5 g:

- Unique fragment identification number
- GPS coordinates where the debris piece was found
- Weight as determined using a platform balance
- Color of the concrete indicating where the debris originated (roof or which wall)
- Photo number (if a photograph was taken)
- Additional comment, such as “rebar”

These data were entered into a spreadsheet database. The GPS coordinates and concrete color data were used to plot fragment maps. The fragment map for Test 4 is presented in Figure I-17 as an illustration and will be discussed later.

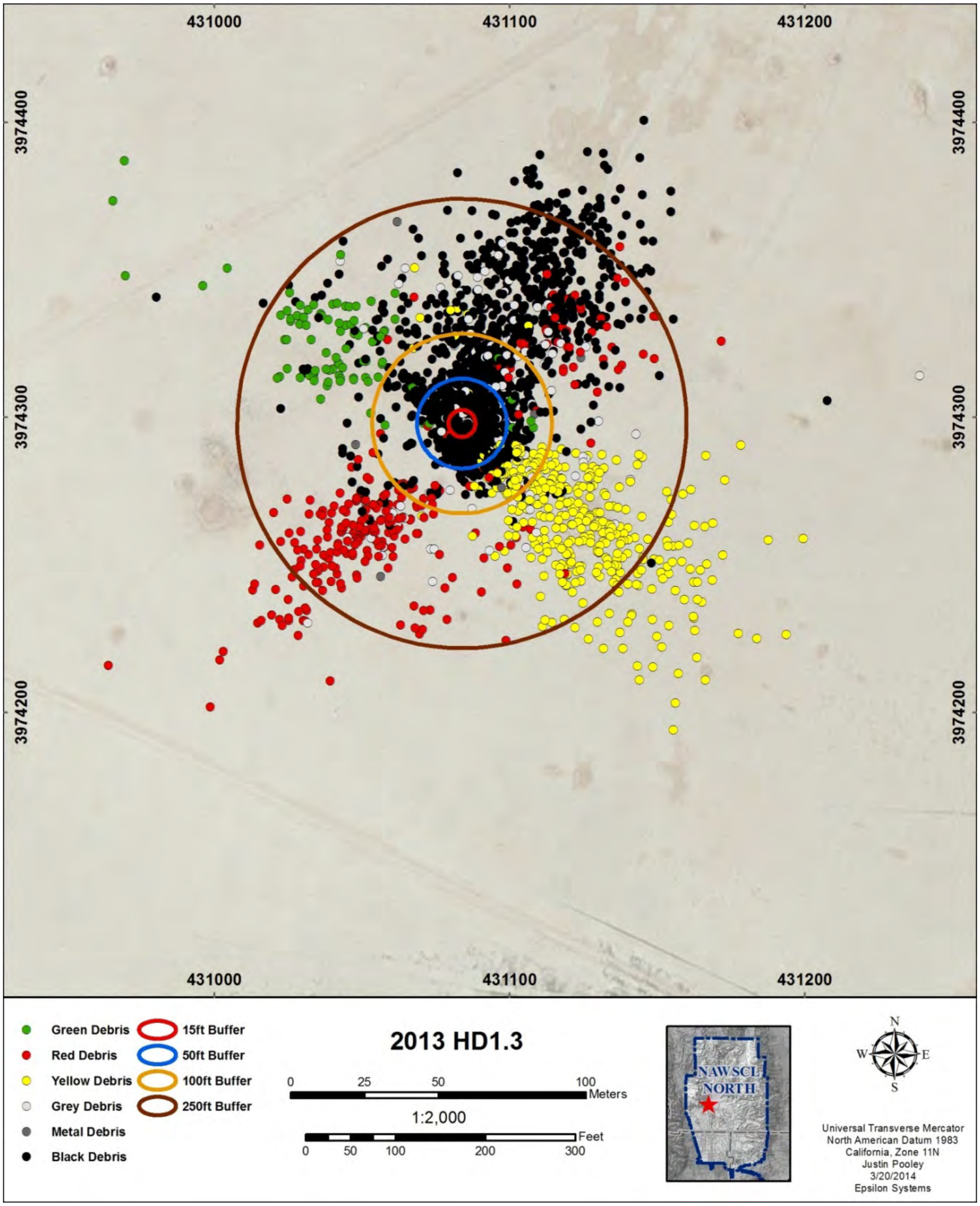


FIGURE I-17. Fragment Map of Test 4.

SYNOPSIS OF MAJOR TEST RESULTS

A brief discussion of the results from Tests 1 through 4 is presented in this synopsis. The detailed data from the four tests are presented in the Chapters II through V, one chapter for each test. Chapter VI provides an overview of the modeling effort.

Two general outcomes were observed in Tests 1 through 4:

- Regarding the unchoked flow condition (Tests 1 and 3), the structure remained intact, with a luminous plume exiting the structure.
- Regarding the choked flow condition (Tests 2 and 4), the structure ruptured resulting in structural debris, some of it being very large fragments weighing a kilogram or more, being projected a large distance.

The resulting loading densities and vent area ratios for the four tests are shown in Figure I-18 with the tests discussed in this report indicated in blue (choked or unchoked China Lake tests).

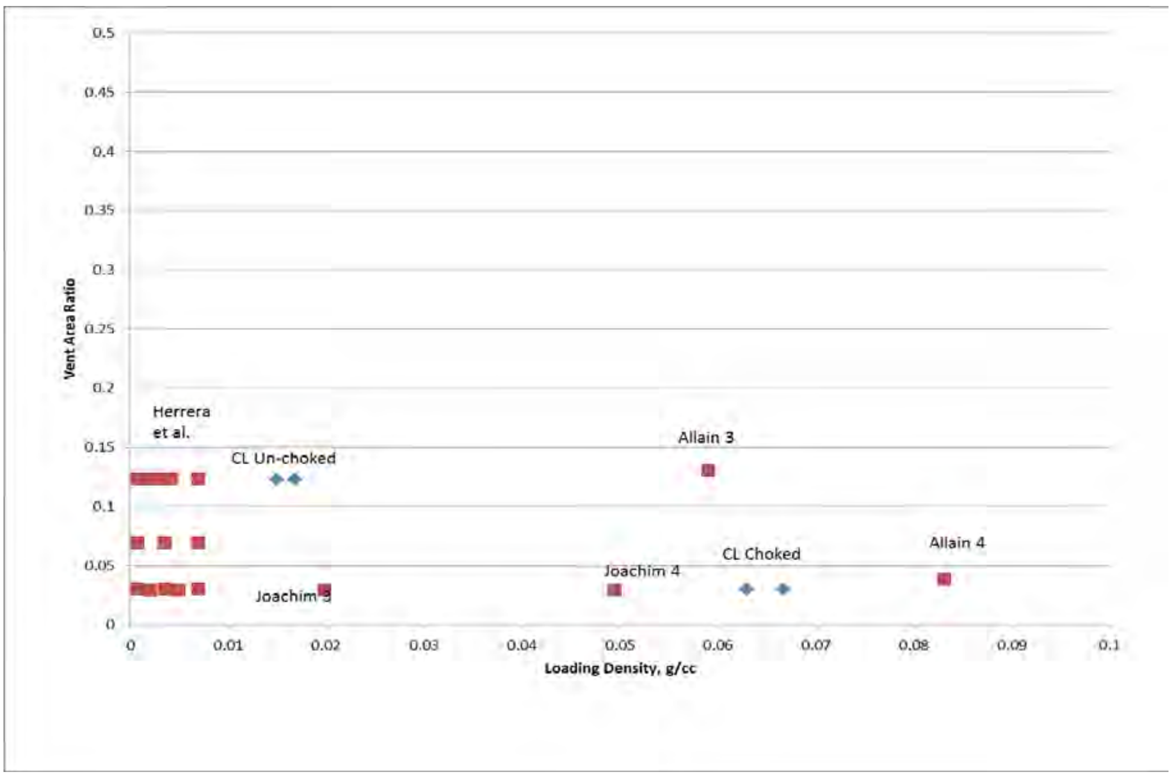


FIGURE I-18. Loading Densities and Vent Area Ratios
With China Lake Tests 1 Through 4 Added.

Tests 1 and 3, with the 79-cm diameter vent, developed very little pressure increase (~1 psi pressure increase) inside the structure due to combustion of the M1 gun propellant resulting in unchoked flow. Chapters II and IV discuss the details of Tests 1 and 3, respectively.

The high-speed videos for Tests 1 and 2 provided a field of view about 10 to 12 feet on either side of the structure and about 12 feet above the structure. Unfortunately, the plume length of Test 1 exceeded the field of view for a significant portion of the run time, and the fireball, when the structure ruptured in Test 2, also exceeded the field of view. Adjusting the optics in Tests 3 and 4 provided a wider field of view. Still photos from the high-speed videos are presented in Figures II-12 to II-14 for Test 1; Figures III-16 to III-20 for Test 2; Figures IV-17 to IV-19 for Test 3; and Figures V-15 to V-24 for Test 4. Table I-3 provides a brief summary of some of the times after ignition and the corresponding plume length and/or fireball dimensions. Figure I-19 illustrates the plume for unchoked flow. The flow for Tests 1 and 3 was unchoked for the entire test with a luminous white plume, and in the first few seconds of Tests 2 and 4 before the structure failed. Figure I-20 illustrates the fireball typical of tests after the structure ruptured.

TABLE I-3. Summary of Fireball and Plume Data.

Test	Time After Ignition, seconds	Plume Length, feet	Fireball	
			Diameter, feet	Length, feet
1	1.25	14		
	8.6	>30		
	26.8	9		
2	1.5	>15		
	~2		14	>15*
	3		~25	>15*
	5		>*	30**
	17		~7	10-15**
3	2	7.5		
	6	35 white, 49 total		
	13	~8		
4	2	30		
	4		25	60**
	5		38	>90**
	7		30	>90**
	13		30	90**
	14		10	45**
	20		3	~6**

* exceeded field of view

** plume rising in elevation with distance from structure

FIGURE I-19. Still Picture Taken From Video of
Test 3 at 6 Seconds After Ignition.

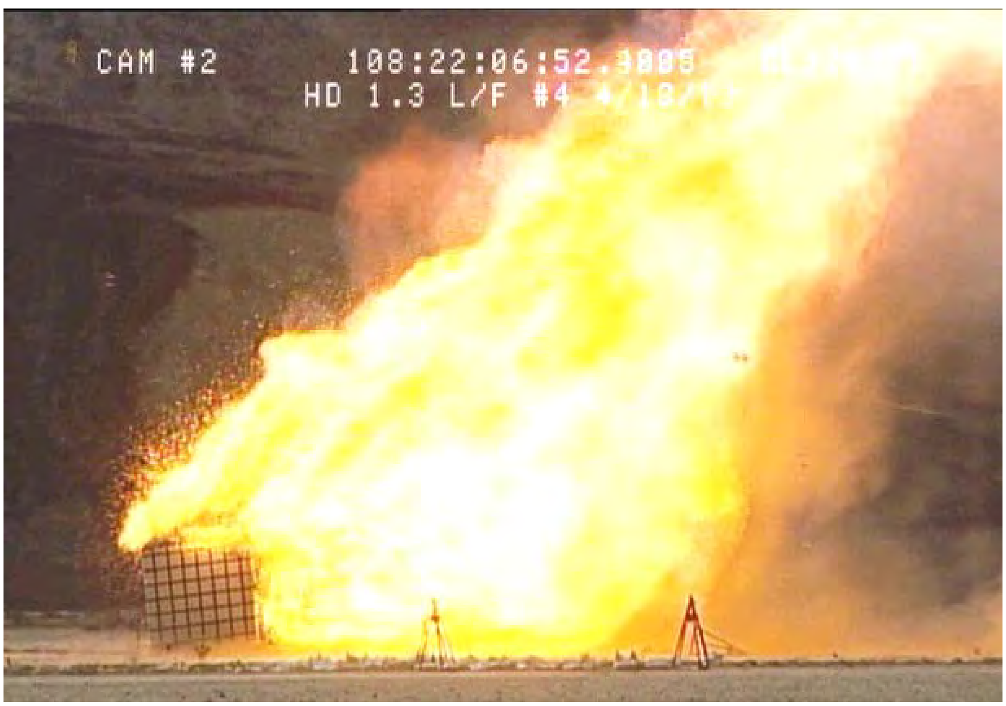


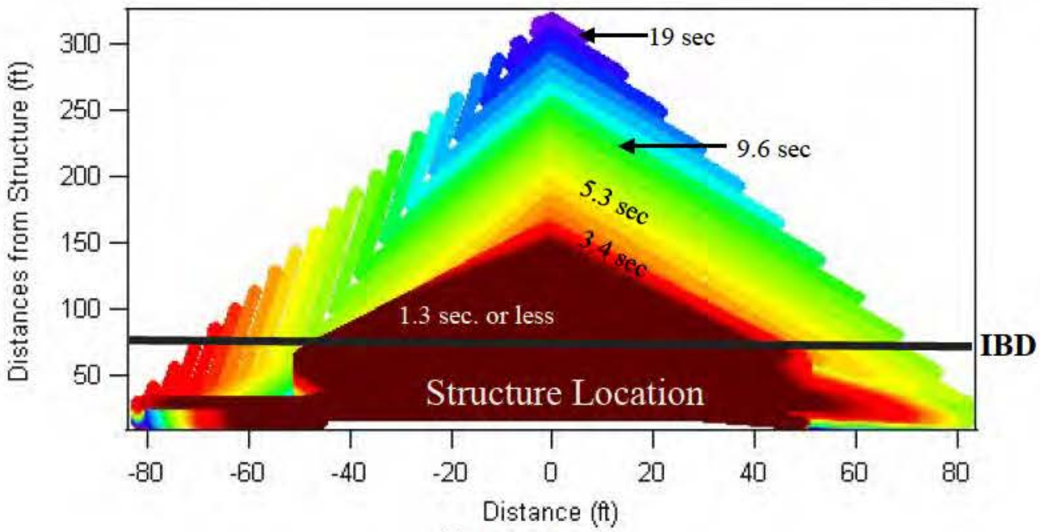
FIGURE I-20. Still Picture From Video Taken of Test 4 at 5 Seconds
After Ignition (After Rupture of the Structure).

The fireball in Tests 2 and 4 extended upward following rupture when the structure rocked backward, as opposed to the plumes of Tests 1 and 3 that were horizontal across the ground. This is important because the fireballs were above the DFTs, higher with increased distance from the original structure (again, seen in the above figures and in those of the accompanying chapters); therefore, the plume length and heat flux produced could not be measured from Tests 2 and 4.

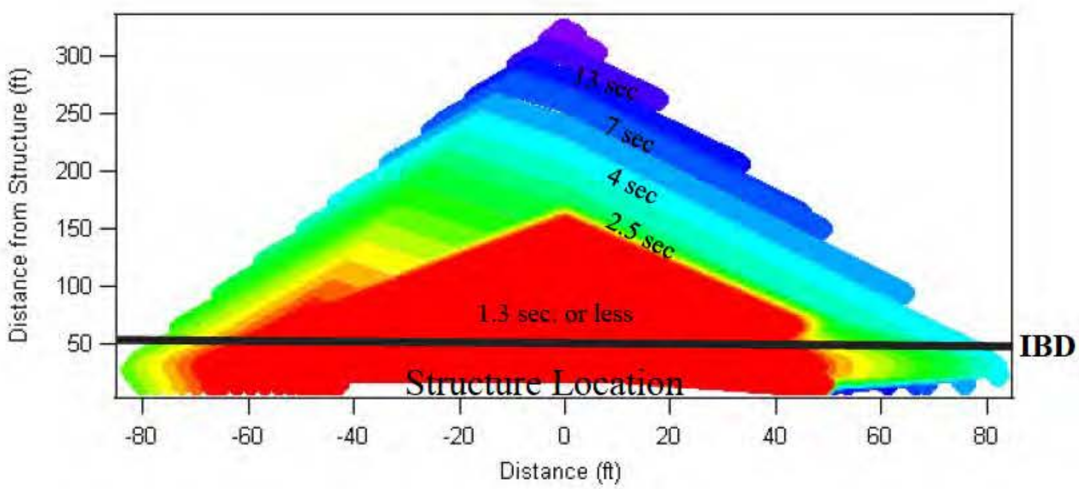
Surface plots of the external heat fluxes for Tests 3 and 4 are seen in Figure I-21a-b. These surface plots have been generated using the peak flux measurements at each gage location. The flux measurement has been replaced with calculated exposure required to sustain second degree burns. Exposure times calculated beyond the IBD range from 19 seconds (at 300 feet from the structure) to 1.3 seconds or less. The petroleum industry uses a criterion of 5 kW/m^2 at the boundary fence as one of their safety criterion for fire in refineries (Reference I-7). This gives a person exposed 19.1 seconds to recognize the threat and take evasive action. Using the 5 kW/m^2 criteria the safe distance for these events would have to exceed 300 feet, using the flux measurements from Test 3.

A search of the literature for M1 heat flux data was performed in order to compare the heat fluxes measured in this program to those previously measured. Heat fluxes ranged from 0.084 to 243 kW/m^2 depending on the location that the heat flux was measured and the amount of material burned. Heat fluxes reported for the M1-type gun propellant can be found in Appendix I-D. Chapters III through V show that heat fluxes measured from Tests 2 through 4 range from 2.28 to 15,027.93 kW/m^2. Overall, the data from the tests compare with the literature values. The highest flux values are found inside the plume and close to the structure.

Tests 2 and 4 with the 39-cm-diameter (15.4-inch) vent, resulted in choked flow producing a pressure increase inside the structure that caused rupture and projection of structural debris, much of it very large fragments (greater than 1 kg). Many of these large fragments were thrown several hundred feet from the original structure. The structure in Test 2 ruptured at 1.4 seconds after the ignition pulse to the gun propellant when the pressure in the interior of the structure reached approximately 47 psi. The structure in Test 4 ruptured at about 2.3 seconds after ignition pulse to the gun propellant when the internal pressure reached approximately 34.1 psi. The differences between the two tests are attributed to the difference in propellant geometry and hence difference in mass burning rate as discussed earlier.



(a) Test 3.



(b) Test 4.

FIGURE I-21. Calculated Times for 2nd Degree Burns Using Peak External Heat Flux.

The NAWCWD Combustion Science Branch used ANSYS Fluent Computational Fluid Dynamics (CFD) models developed for Reference VI-6 and adapted them for the Kasun structure using M1 gun propellant. The models calculated the internal pressurization of the structure for Tests 2 and 4. The models also predicted the plume extending out the front of the structure. In the models, the maximum temperature calculated in the plume was slightly above 1500°C. This was consistent with temperature above 1250°C being measured when the propellant burned in the test. The models also calculated an internal pressure of 46.4 psi when attempting to predict Test 2 pressure conditions. The calculated pressure compares to the 46.54 psi measured in Test 2.

Chapters III and V describe the structural breakup with many still photos taken from the high-speed videos for Tests 2 and 4, respectively. The structures ruptured quickly in Tests 2 and 4, and at relatively low pressure. As a result, little of the gun propellant had burned before the rupture. Most of the gun propellant burned after the structure rupture producing very large fireballs. The hazards associated with the fireballs, as well as the structural debris, must be considered in determining safe-separation distances associated with mass fire of HD1.3 materials.

The Naval Facilities Engineering Command Engineering and Expeditionary Warfare Center (NAVFAC EXWC) modeled the structural response of the Kasun structure in LS-DYNA. The Kasun structure was modeled according to the drawings; deviation from drawing design on how the door was tied in was made based on post-test pictures following rupture of the structure from Tests 2 and 4. The pressure-time histories from Tests 2 and 4 were used to apply the load to the walls of the structure. The models were able to simulate many of the failure mechanisms observed in Test 2 but overpredicted the damage to the structures. The simulations were unable to duplicate the damage level observed in Test 4.

The fragment maps for Tests 2 and 4 are shown in Figures I-22 and I-23. A total of 2,609 fragments were collected in Test 2 and 3,042 fragments in Test 4. The fragment maps for Tests 2 and 4 are interesting by themselves and in comparison to each other. The fragment map for Test 2 shows that most of the fragments (black fragments) came from the roof of the structure, with some coming from the back (south) wall (red) and some from the front (north) wall (gray). Many of the fragments were found more than 100 feet from the original structure, and some were found over 250 feet from the structure. Approximately 110 fragments were quite large weighing more than 1 kg. The largest fragment for Test 2 was 8.4 kg. (Note: More detailed discussion of the Test 2 fragments is presented in Chapter III.)

The fragment map for Test 4, shown in Figure I-23, in contrast to that of Test 2, shows fragments from the east wall (yellow), the south wall (red), the west wall (green), and the front wall (gray). There were many fragments at distances greater than 100 feet with some at distances greater than 250 feet as in Test 2. Some of the Test 4 fragments were found at more than 450 feet (more than 135 m) from the center of the structure. There were many large fragments greater than 1 kg found, as in Test 2, with the largest fragment weighing 11.55 kg (Note: A more detailed discussion of the fragments from Test 4 is contained in Chapter V).

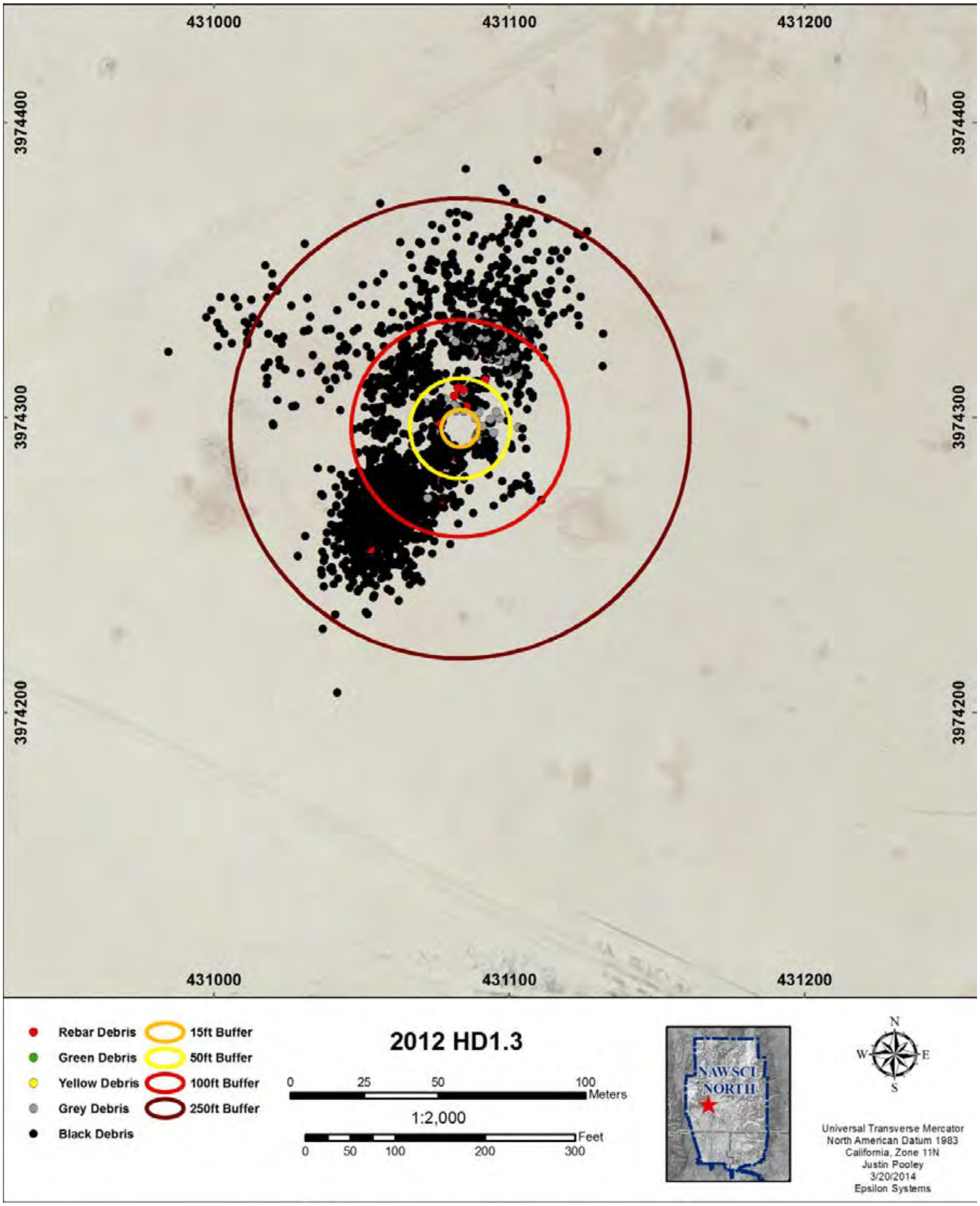


FIGURE I-22. Fragment Map From Test 2 Conducted on 15 December 2012. The fragment map shows that most of the fragments were from the roof (black concrete).

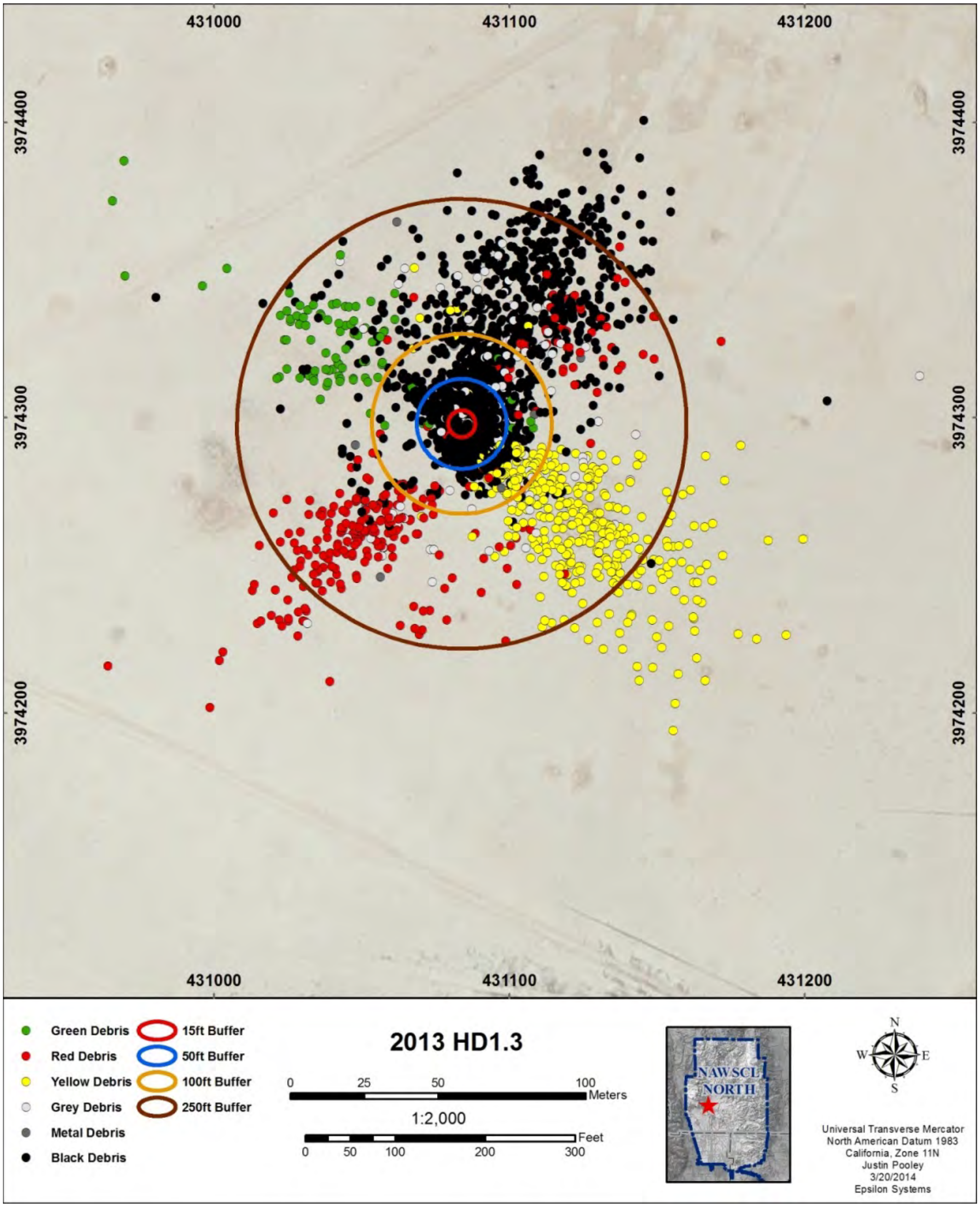


FIGURE I-23. Fragment Map of Test 4.

The fragment maps of Tests 2 and 4 are compared to the quantity-distance hazard arcs, given in DODM-6055.09, Table V3.E3.T14 HD1.3 QD (Reference I-1) in Figures I-24 and I-25, respectively. There were 1,176 pounds of M1 gun propellant in Test 2 and in Test 4, there were 1,108 pounds of M1 gun-propellant loaded into the structure. The geometry of the individual M1 grains was different in the two tests resulting in different flame spread, ignition and pressurization as discussed earlier. Table V3.E3.T14 of DODM 6055.09 lists the inhabited building distance (IBD) and public traffic route distance (PTRD) for 1,500 pounds of HD1.3 material as 82 feet and the inter-magazine distance (IMD) and the intraline distance (ILD) as 56 feet for the 1,500 pounds (Reference I-1). The blue circle in each of Figures I-24 and I-25 indicates the 82-foot radius IBD/PTRD from the center of the structure, while the green circle is the 56-foot IMD/ILD radius for 1,500 pounds. Using the table found in Reference I-1, Table V3.E3.T14 lists an 82 foot IBD/PTRD and a 56 foot IMD/ILD for 1,500 NEW. All of the subsequent tests are below the 1,500 NEW benchmark. The tabulated IBD and IMD are used in this document to demonstrate trends and to address general correlations between tests. Reference II-1 also provides an equation for calculating IBD and IMD (EQN V3.E3.T14-1). The equation is used in the following chapters to calculate the IBD and IMD for each test.

The amount of M1 propellant burned in Tests 2 and 4 was less than 1,500 lbs as reported above, and Reference I-1 was used to calculate the IBD/PTRD at 76 and 75 for Tests 2 and 4, respectively. An ILD/IMD of 50 feet for both tests was also calculated. Obviously, many of the fragments in Figures I-24 and I-25 are well beyond the IBD and IMD/ILD distances.

The fragmentation results (Tests 2 and 4) were compared to the results obtained by using the DDESB approved siting tools (Explosive Safety Siting [ESS] and Safety Assessment for Explosive Risk [SAFER]). APT Research also compared the HD1.3 testing to those of a similar structure with HD1.1 explosive. Tests 2 and 4 were modeled strictly as HD1.3 events, HD1.1 events, and modified HD1.1 events based on TNT equivalency.

When modeled as HD1.3 events, the inhabited building distance (IBD) and the public traffic route distance (PTRD) was approximately 75 feet, which is the minimum default IBD/PTRD for the models. The intermagazine distance (IMD) and intraline distance (ILD) was calculated to be 50 feet for all four tests with a HD1.3 material using the net explosive weight (NEW) from each test. Tests 2 and 4 produced fragments beyond the distances approved for public building or highways (IBD/PTRD).

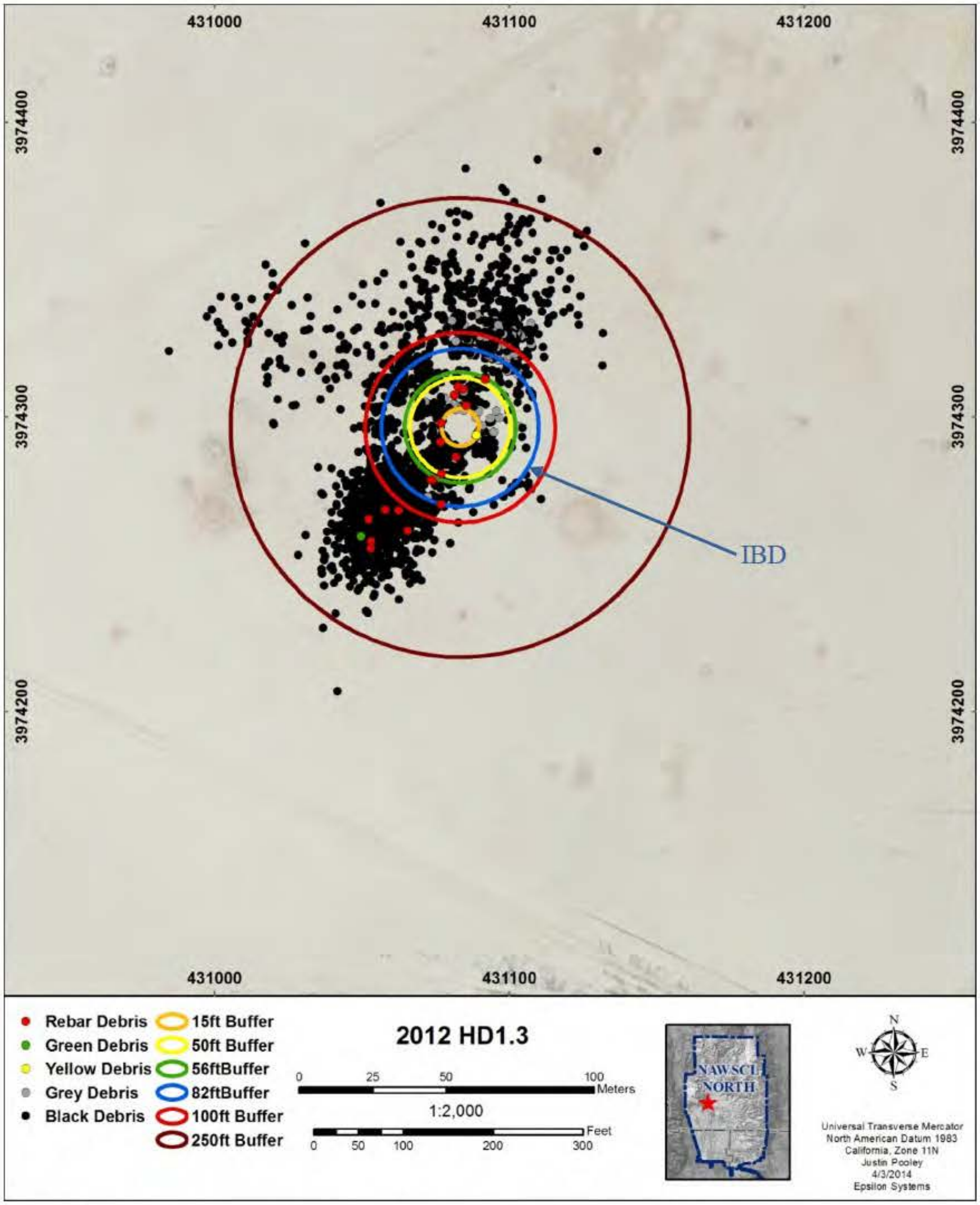


FIGURE I-24. Fragment Map of Test 2 With the 82-Foot QD IBD/PTRD Arc From Table V3.E3.T14, DODM-6055.09 in Blue and the IMD/ILD QD Arc in Green.

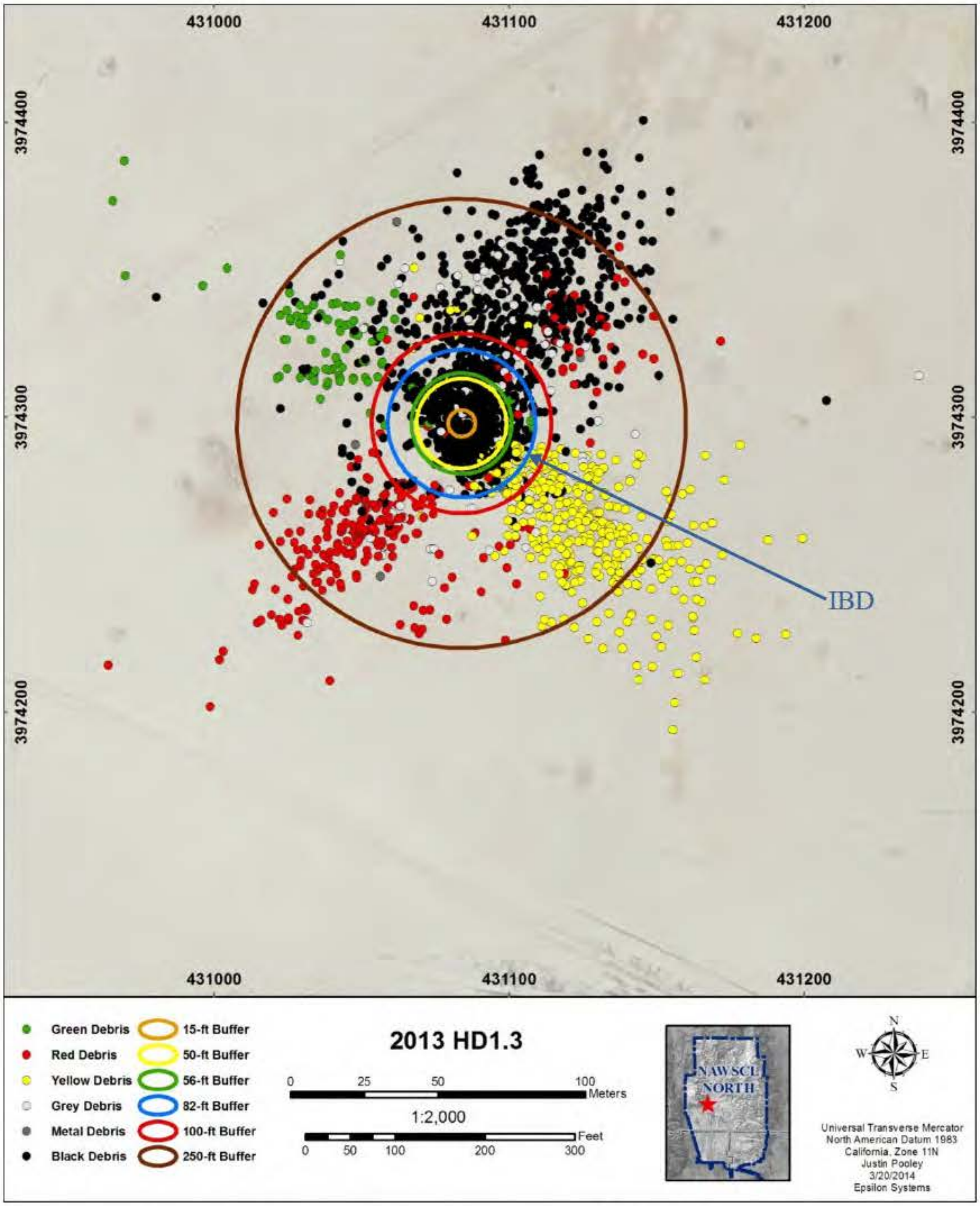


FIGURE I-25. Fragment Map of Test 4 With the 82-Foot (25 m) QD IBD Arc From Table V3.E3.T14, DODM-6055.09 in Blue and the 56-Foot (17 m) IMD QD Arc in Green.

ESS was also used to evaluate the IBD and IMD for Tests 2 and 4 based on HD1.1 material. The IBD and IMD for were calculated at 1,250 feet and 750 feet. The farthest fragment measured from test 2 was 341 feet, and the farthest fragment measured from Test 4 was 508 feet. This method of calculating IBD extends the hazard arc 2.5 times farther than the farthest fragment measured. This method is grossly conservative.

The ESS model was then used to calculate the IBD and IMD using a modified HD1.1 formula. The calculated IBD/PTRD was 395 feet, under the modified HD1.1 conditions. The IMD/ILD was calculated to be 176 feet. This method of calculating IBD underestimates the hazard arc.

Tests 2 and 4 conditions were also applied to the SAFER model. In the risk based approach, HD1.3 has primarily a thermal hazard. For conditions of Tests 2 and 4 with HD1.3 in a concrete structure, the fireball radius was calculated to be 35.2 feet (Test 2) and 34.6 feet (Test 4). These conditions used over 1,000 pounds of HD1.3 material. The plume from Tests 1 and 3 (~300 lbs NEW) extended beyond the 35 feet. SAFER was also inadequate for predicating the pressure, impulse, and debris density for Tests 2 and 4. Details of the modeling effort can be found in Chapter VI.

DISCUSSION

Figures I-24 and I-25 illustrate that many fragments were projected well outside the QD arcs given by Table V3.E3.T14 HD1.3 QD of DODM-6055.09 (Reference I-4). As mentioned above, these fragments were often very large. The plots also show that many of the areas had more than one lethal fragment per 600 square feet. Given this projection, it is recommended that Section E of 6055.09 be rewritten to reflect these test data.

Figures I-22 and I-23, along with the pressure data from Tests 2 and 4, demonstrate the influence of propellant mass regression rate on the response of the structure. The slower pressurization of the structure found in Test 4 allowed more work to be done on the structure even though the maximum recorded pressure in the structure was less than the pressure recorded for Test 2. The faster burning material used in Test 2 produced smaller fragments that were projected less distance compared to those produced in Test 4.

The heat flux data from Tests 1 through 4 of the China Lake tests, with the data removed for sensors directly in the plume/fireball, agree well with the data of Hay and Watson (Reference I-12), as well as Allain, when compared to the flux values found in Appendix I-D.

While the heat flux data are interesting, with fluxes in the tens and hundreds of kW/m^2, it must be remembered that all of the tests were relatively small-scale tests. Tests should be conducted with larger scale structures with heat fluxes at various distances

determined. This would be critical to determine safe-separation distances due to mass fires, as fire does not scale (Reference I-13). For these events, the accepted exposure limit of $5kW/m^2$ is at or beyond 300 feet.

The vent area ratio-loading density plot of Figure I-1 is shown again for convenience in Figure I-26 with two highlighted areas. The plot shows a highlighted area to left of the plot with unchoked flow and no rupture of structure and no structural debris. The highlighted area at the right of the plot shows the conditions resulting in rupture of the structure and projection of debris. The figure also shows a gap in the data, roughly between 0.02 g/cm^3 and 0.05 g/cm^3 loading density, where there is no data to define the two regions. Obviously, more data are needed in order to positively define the two regions. Given this reservation, if additional data continue to show the two discreet areas, this type of plot might be used to predict how much gun propellant could be stored in a magazine without causing choked flow and subsequent rupture of the magazine with projection of debris if the contents of the magazine caught fire.

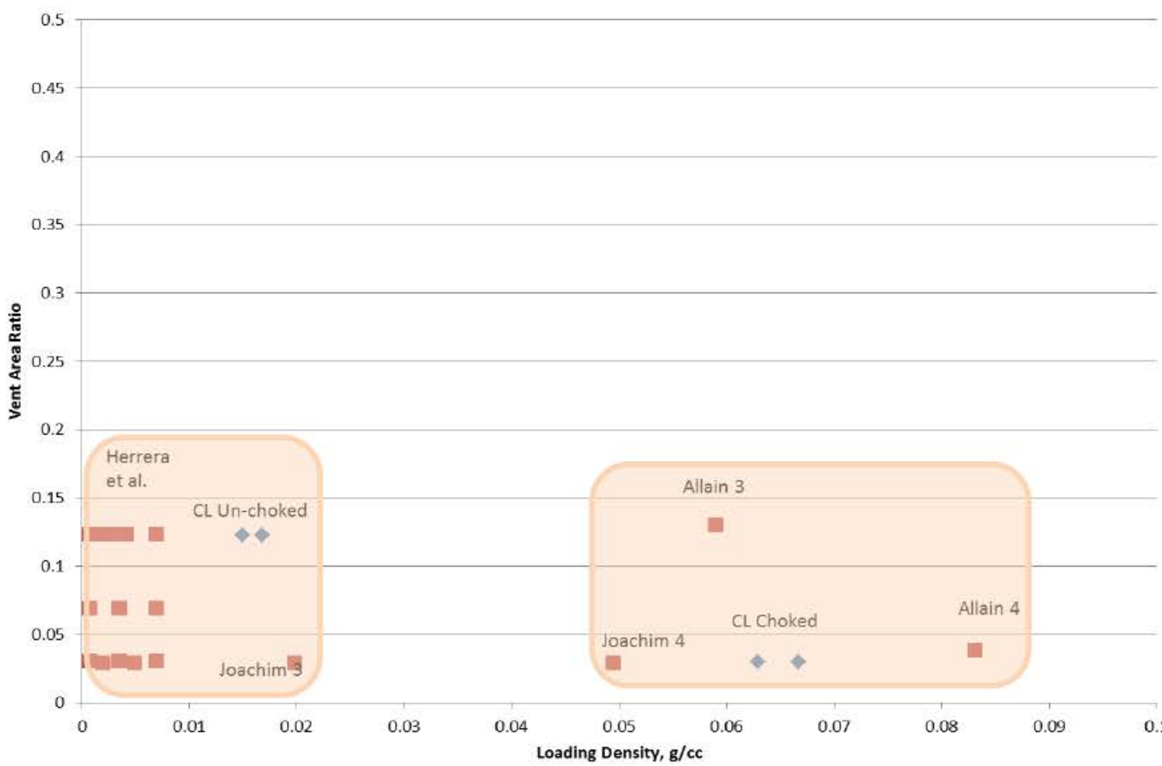


FIGURE I-26. Vent Area Ratio and Loading Densities of China Lake Tests 1 Through 4.

Take an example problem of how much M1 gun propellant could be stored in various lengths of the Modular Storage Magazine (MSM). The MSM is 25 feet wide by 11 feet high by various lengths. The lengths are 20, 40, 60, and 80 feet long. We know from Figure I-26 that loading densities of M1 propellant of 0.02 g/cm^3 or less would

result in unchoked flow and no rupture of the magazine. We also know that a test with 0.05 g/cm^3 loading density of M1 did result in choked flow and rupture of the structure and projection of structural debris. What we do not know is what happens between loading densities of 0.02 and 0.05 g/cm^3. Additional test data in that interval would be most helpful but are not currently available. Table I-4 presents the various lengths of MSM and how much M1 could be stored in the magazine and still have unchoked flow (0.02 g/cm^3 or less), and how much would result in choked flow and magazine rupture (0.05 g/cm^3).

Placement of 53,565 pounds or more of M1 in the 60-foot magazine in the MSM example of Table I-4 (357 19-inch-diameter by 26-inch-tall barrels each holding 150 pounds of M1 gun propellant), would most likely result in choked flow with rupture of the structure and projection of large debris fragments well beyond the 268 feet from the Table V3.E3.T14 for IBD from 6055.09-M-V3 (See paragraph below for caveat). Loading the structure with 21,426 pounds (only 143 19-inch-diameter by 26-inch-tall barrels) would result in unchoked flow and no rupture of the structure.

TABLE I-4. Weights of M1 Gun Propellant That Can be Stored in Various MSMs for Unchoked, Choked Flow.

Length of MSM, feet	Volume, ft^3	Weight, pounds (to give indicated loading densities)	
		0.02 g/cm^3(1.24 lb/ft^3) (unchoked flow)	0.05 g/cm^3(3.11 lb/ft^3) (choked flow and rupture)
20	5,720	9,142	17,855
40	11,440	14,284	35,710
60	17,160	21,426	53,565
80	22,880	28,568	71,420

The previous paragraphs did not discuss the contribution of vent area ratio (vent area/volume$^{2/3}$). The vent areas, considering the two doors of the MSM, are 0.81 for 20-foot length, 0.51 for 40-foot length, 0.39 for 60-foot length, and 0.32 for 80-foot length. The vent area ratio was not discussed, because there are no data for vent area ratios that high in Figure I-26. This is another area where additional data are required.

The test conditions for HD1.3 Tests 1 through 4 were applied to existing models to evaluate the predictive capabilities for HD1.3 hazards. The NWCDDT model, ANSYS Fluent Computational Fluid Dynamics (CFD), LS-DYNA, ESS, SAFER, and several fast running models have been used to simulate the test conditions and results for this series of tests.

The NWCDDT model was used to determine the likelihood of a DDT event. The model validated the theory that the M1 propellant would not DDT in the test configurations of interest. The ANSYS Fluent CFD calculated thermal and pressure profiles inside the structure for Tests 2 and 4. ANSYS Fluent CFD also predicted the formation of the plume outside the structure for Tests 1 through 4.

LS-DYNA was used to model the structural response of the Kasun-like structure for Tests 2 and 4. The pressure-time histories from the tests were used to apply the loads to the walls of the structure. The models were able to simulate many of the failure mechanisms observed in Test 2 but overpredicted the damage to the structures. The simulations were unable to duplicate the damage level observed in Test 4.

ESS and SAFER were used to predict hazard siting for HD1.3 materials. These predications were then compared to the test data to determine if the models were applicable. Three methods were used in SAFER and ESS to predict hazard arcs; treating the event as a HD1.3 event, treating the event as a HD1.1 event, and treating the event as a modified HD1.1 event based on TNT equivalency. When the M1 was treated as a HD1.3 material the ESS model calculated the IBD/PTRD distance was at 75 feet, which is the minimum default IBD/PTRD for the models. The IMD/ILD was calculated to be 50 feet for all four tests with a HD1.3 material using the NEW from each test. Tests 2 and 4 produced a significant amount of fragments beyond the calculated IBD/PTRD (75 feet). This method drastically underestimates the hazard arc for these events.

When the test configurations were modeled as HD1.1 event, or modified HD1.1 event based on TNT equivalency the IBD (Modified TNT:392 ft; HD1.1: 1,250 ft) and ILD (Modified TNT:176 ft; HD1.1: 180 ft), distances are grossly conservative, overproducing the response of the structure and the distance of projected fragments.

SAFER calculated the fireball radius to be 35.2 feet (Test 2) and 34.6 feet (Test 4). These conditions used over 1,000 pounds of HD1.3 material. The plume from Tests 1 and 3 extended beyond the 35 feet (approximately 300 pounds NEW). SAFER also attempted to predict the pressure, impulse, and debris density, but resulted in an over prediction.

Fast running models were evaluated for predicative capabilities, but these models produced results similar to the results discussed above. These fast running models show potential but require further maturation prior to being used for HD1.3 predictions.

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This report presents the results of four tests with a HD1.3 material, M1 gun propellant, in a 2 m by 2 m by 2 m reinforced concrete structure. The results of the four tests show that for combustion of M1 propellant, under conditions that produce choked flow of combustion products and the rapid increase in internal pressure within a structure, can cause rupture of the structure in seconds after ignition and projects structural debris significantly further than the 82-foot (25 m) IBD given in the quantity-distance tables of Volume 3 of DODM 6055.09-M for 1,500 pounds (680.4 kg) of propellant. For example, Test 4 had 1,108 pounds of multi-perforation M1 propellant in the structure and projected structural debris up to approximately 460 feet from the center of the structure. Some of the structural debris was quite large; for example, in Test 4 the largest debris fragment was 11,555 g (25.48 pounds) and was projected 31.5 m (103.3 feet) from center of structure. Over 3,000 fragments weighing more than 5 g were collected, with 136 fragments over 1,000 g each and 552 fragment weighing 100 to 1,000 g.

While the propellant composition was the same in Tests 2 and 4, the geometry of the grains was different. The propellant in Test 2 consisted of smaller sized grains with single perforation versus the propellant in Test 4 with larger sized grains with seven smaller diameter perforations. The propellant in Test 2 produced a faster combustion rate and higher pressurization rate than did the propellant in Test 4 as shown in Figure I-5. However, the structure used for Test 2 ruptured 1.4 seconds after ignition and at 47 psi. The structure used in Test 4 ruptured 2.3 seconds after ignition and at 34 psi. Test 4 produced larger sized structural debris and projected it further.

If the flow is unchoked flow, the pressure in the structure remains low and the structure does not rupture and no structural debris is produced as was demonstrated in Tests 1 and 3.

It is recommended that predictive methods be established that determine when choked flow, and resulting projection of structural debris, will occur, as well as the weight of fragments and associated projection distance. The results from this study, coupled with the results of Joachim (Reference I-4) and Allain (Reference I-5), indicate that if the loading density (weight of the HD1.3 gun propellant/volume of structure) of M1 gun propellant in a structure is equal to or exceeds 0.05 g/cm^3, then choked flow will occur. However, these data do not predict the size, weight, and projection distances of the structural debris. The results of this study, the results of Joachim, and Herrera, et al., indicate that if the loading density is 0.02 g/cm^3 or less then unchoked flow will occur and the structure will not rupture. Note should be taken that there is no data on the effect of scale on the propensity to produce choked rather than unchoked flow in a structure.

This report gives examples of various loading densities of M1 gun propellant in various MSMs that would give unchoked (good) or choked (bad) flow, again neglecting the unknown effects of scale and large vent area ratios.

It is recommended that Table V3.E3.T14 HD1.3 QD of DODM 6055.09 (Reference I-1) be changed to reflect the increased hazard of large pieces of structural debris projected well beyond the distances given in the table for given weights.

Projection of structural debris is not the only hazard in a combustion driven event. The pressures causing rupture were produced by only a relatively small amount of the gun powder burning. The rest burned after the rupture resulting in a very large fireball that lasted approximately 15 seconds after ignition of propellant and about 13 seconds after rupture of the structure. Direct exposure to the fireball would result in fatalities (although an individual may have already succumbed to impact by structural debris.). Radiation from the fireball can also cause fatalities outside the visible fireball given sufficient heat flux and exposure time. DOD M6055.09 has recently been amended to prevent second- and third-degree burns, using the equation recommended by the Society of Fire Prevention Engineers, $t = 200\ q^{-1.46}$, where t is the minimum exposure time to a heat flux to produce second-degree burns in seconds, and q is the heat flux in kW/m^2. For example, 15 kW/m^2 would produce second-degree burns in 3.84 seconds, while 5 kW/m^2 would produce second-degree burns in 19.08 seconds. Times less than 4 seconds do not provide enough time to recognize the threat and seek protective cover, while 19 seconds does provide time to recognize the threat and take cover.

Any risk-based approach for determination of safe-separation distances from mass fire of HD1.3 must address the hazard risks previously mentioned. Projection of structural debris, location of fireball, and radiant heat flux at distance and exposure time from the fireball (prevention of second- and third-degree burns) should be considered for the choked flow condition. The hazard in the unchoked flow condition is primarily due to the location and extent of the external plume(s), the expulsion of unburned propellant through the vents that burns exterior to the structure, and the radiant heat flux at distance and exposure time from the plume(s) in the unchoked flow condition.

Unfortunately, there is not an extensive database to draw from as shown in Figure I-26 in this report. There are only the five examples of choked flow with M1-type gun propellant, and all of the examples resulted in rupture of structure with debris throw within seconds after ignition (two tests by Allain [Tests 3 and 4], one from Joachim [Reference I-3], and two from this study). Allain performed two other tests (Tests 1 and 2) with M1-type propellant, but the structures were not secured to the ground. In Allain's Tests 1 and 2, when the pressure built up internal to the structure, the structures rose above the ground allowing gas pressure to escape from the structure, resulting in "no-tests." Herrera et al. (Reference I-6) tested several gun propellants including single perforation M1 and multi-perforation M1 but all of their results were for unchoked flow. Joachim had three unchoked test results, and this report presented results from two tests of unchoked flow with single perforation and multi-perforation M1 propellant. All of the choked flow tests resulted in structure rupture and projection of structural debris, while all of the unchoked flow tests resulted in no rupture.

There is a gap in data for loading density between 0.02 g/cm^3 (resulting in unchoked flow) and 0.05 g/cm^3 (choked flow). It is recommended that additional tests be conducted with M1 propellant to close this gap and provide a better threshold for transition from unchoked to choked flow. Also evident in Figure I-25, there are also limited data over a range of vent area ratio (vent area ratio = vent area/volume of structure $^{2/3}$). It is recommended that additional tests be designed to address this deficiency.

It is recommended that additional tests be conducted with other HD1.3 energetic materials (other than M1 gun propellant) in conditions that would result in choked flow.

The testing has been conducted using relatively small-scale structures. At some point, testing in larger structures and fires need to be done in order to gain an understanding of the scaling effects on the combustion driven events as large fires do not scale (Reference I-13).

It is also recommended that tests with mixed storage (HD1.1 and HD1.3) be conducted because Reference I-3 showed that fire is the first reaction in over 75% of the accidents surveyed, and mixed storage is common practice.

This effort used several existing models to evaluate the ability to predict a similar event containing HD1.3 material. Structural models demonstrated an ability to predict failure mechanisms but could not accurately address the damage. Thermal models showed positive results when predicting internal pressure and temperature. Fast running models show potential but require further maturation prior to being used for HD1.3 predictions. Both risk based and quantity distance criteria were inadequate in estimating either the fragmentation or the thermal hazard created from the HD1.3 event. However, attempts to use either HD1.1 siting criteria or TNT NEW criteria overestimated the hazard. Work is currently underway to develop models that will be able to predict both the thermal and fragmentation hazard.

It is recommended that further development be made towards all the models used in this effort to improve the accuracy of the predictions.

REFERENCES

I-1. Office of the Deputy Under Secretary of Defense (Installations and Environment). *DOD Ammunition and Explosives Safety Standards.* Washington, D.C., USD(I&E), 29 February 2008. Administratively Reissued 4 August 2010. (DODM 6055.09-M, Volume 1, Enclosures 8 and 9; publication UNCLASSIFIED.)

I-2. A. I. Atwood, K. P. Ford, A. L. Daniels, C. J. Wheeler, T. M. Lyle, P. O. Curran, T. L. Boggs, and J. Covino. "Ignition and Combustion Studies of Hazard Division 1.1 and 1.3 Substances," presented at the 34th DDESB Seminar, Portland, OR, July 2010. Paper UNCLASSIFIED.

I-3. Naval Air Warfare Center Weapons Division. *Realistic Safe-Separation Distance Determination for Mass Fire Hazards* (U), by T. L. Boggs, K. P. Ford, and J. Covino. China Lake, CA, NAWCWD, March 2013. (NAWCWD TM 8668, publication UNCLASSIFIED.)

I-4. U.S. Army. *KA_III, Phase C, M1 Propellant Tests: Deflagration in Partial Confinement* (U), by C. E. Joachim. Vicksburg, Mississippi, U.S. Army, Waterways Experimental Station, Corps of Engineers, July 1991. (Technical Report SL-91-11, publication UNCLASSIFIED.)

I-5. L. Allain. *Combustion of Gun Propellant in Igloo, Thermal Flux Measurements*. SNPE, 30 December 1991, NT No. 153/91/-S/TS/NP, 63 pp.

I-6. Southwest Research Institute. *A Study of Fire Hazards from Combustible Ammunition, Effects of Scale and Confinement (Phase II)*, by W. R. Herrera, L. M. Vargas, P. M. Bowles, F. T. Dodge, and W. E. Baker. San Antonio, Texas, SwRI, December 1984. Contract MDA903-82-C-0526, SwRI Project 01-7327, 188 pp.

See also:

W. R. Herrera and L. M. Vargas. "DODESB Igloo Confinement Test Program," Minutes of the 23rd Explosives Safety Seminar, 9-11 August 1988, Vol. I, pp. 515-539.

I-7. American Petroleum Institute. "Guide for Pressure-Relieving and Depressurizing Systems," Washington, D.C., American Petroleum Institute, 1997. (API 521, publication UNCLASSIFIED.)

See also:

References 81 through 91 in Reference I-3.

I-8. A. I. Atwood, K. P. Ford, N. C. Davis, J. E. Wilson, T. L. Boggs, P.O. Curran, and J. Covino. "Hazard Division 1.3 Ordnance in the U.S. Navy Inventory," presented at the 34th DDESB Seminar, Portland, OR, July 2010. Paper UNCLASSIFIED.

I-9. L. H. Christensen, and S. Skudal. "Test Program with Small "Kasun" Houses," Norwegian Defence Estates Agency (Forsvarsbygg), Norway. (FoU Rapport nr. 24/2004.)

I-10. *Thermocouples-An Introduction*. Retrieved 16 November 2014, from Omega Engineering Corporation: http://www.omega.com/thermocouples.html.

I-11. ASTM International. *Standard Test Methods for Determining Effects of Large Hydrocarbon Pool Fires on Structural Members and Assemblies*. West Conshohocken, PA, December 2010, *E1529-10.*

I-12. J. E. Hay and R. W. Watson. *Scaling Studies of Thermal Radiation Flux from Burning Propellants.* Department of Interior, Bureau of Mines, Washington, D.C., 1992, ADA 527505, 20240, pp. 233–268.

I-13. J. P. Spinti, E. G. Eddings, P .J. Smith, and A. F. Sarofim. "Heat Transfer to Containers in Pool Fires," in Transport Phenomena in Fires, WIT Press, Southampton, United Kingdom, 2006.

Appendix I-A

STRUCTURE DATA FOR TESTS 1 THROUGH 4

(The contents of this appendix are reproduced in facsimile.)

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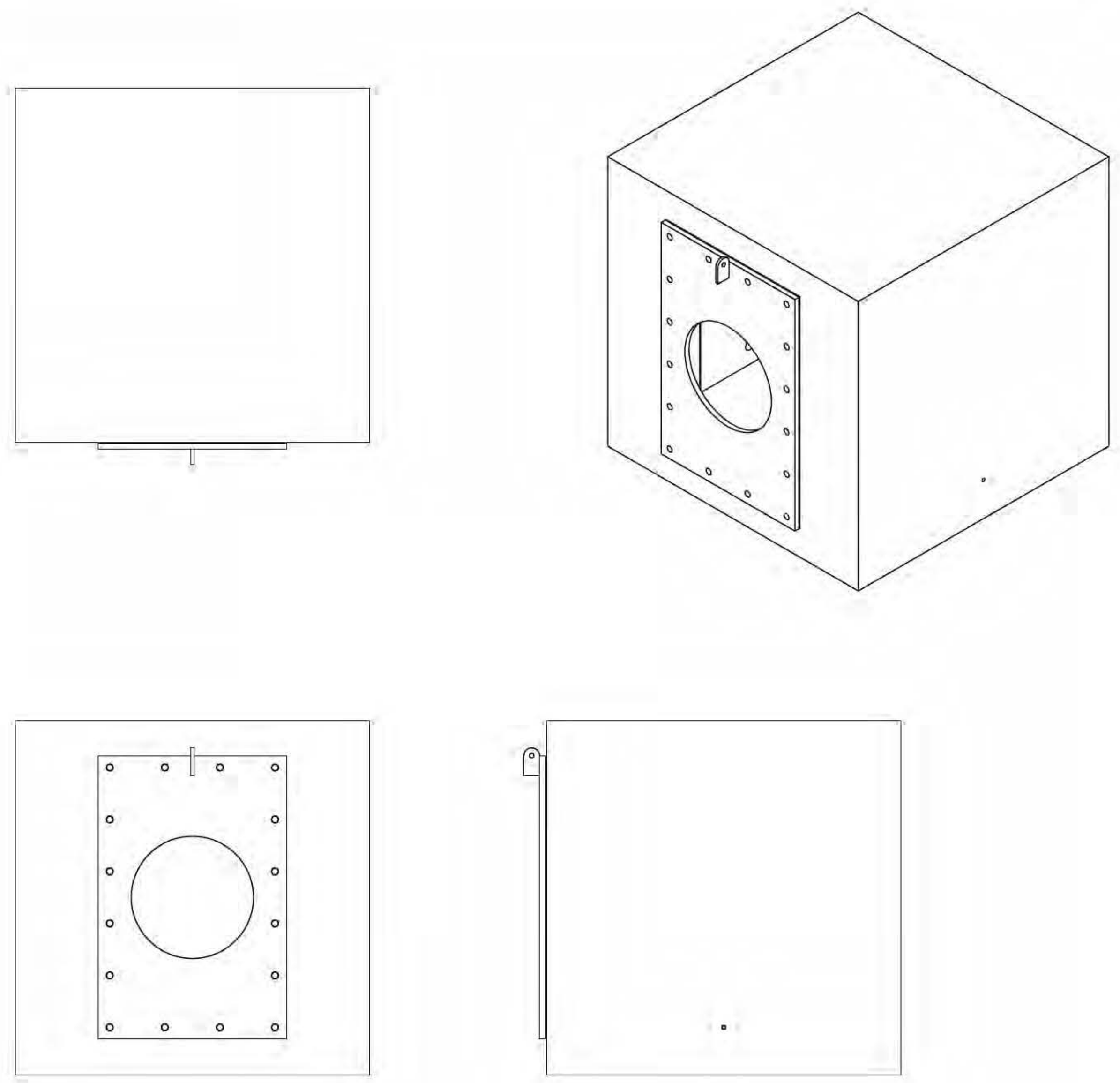
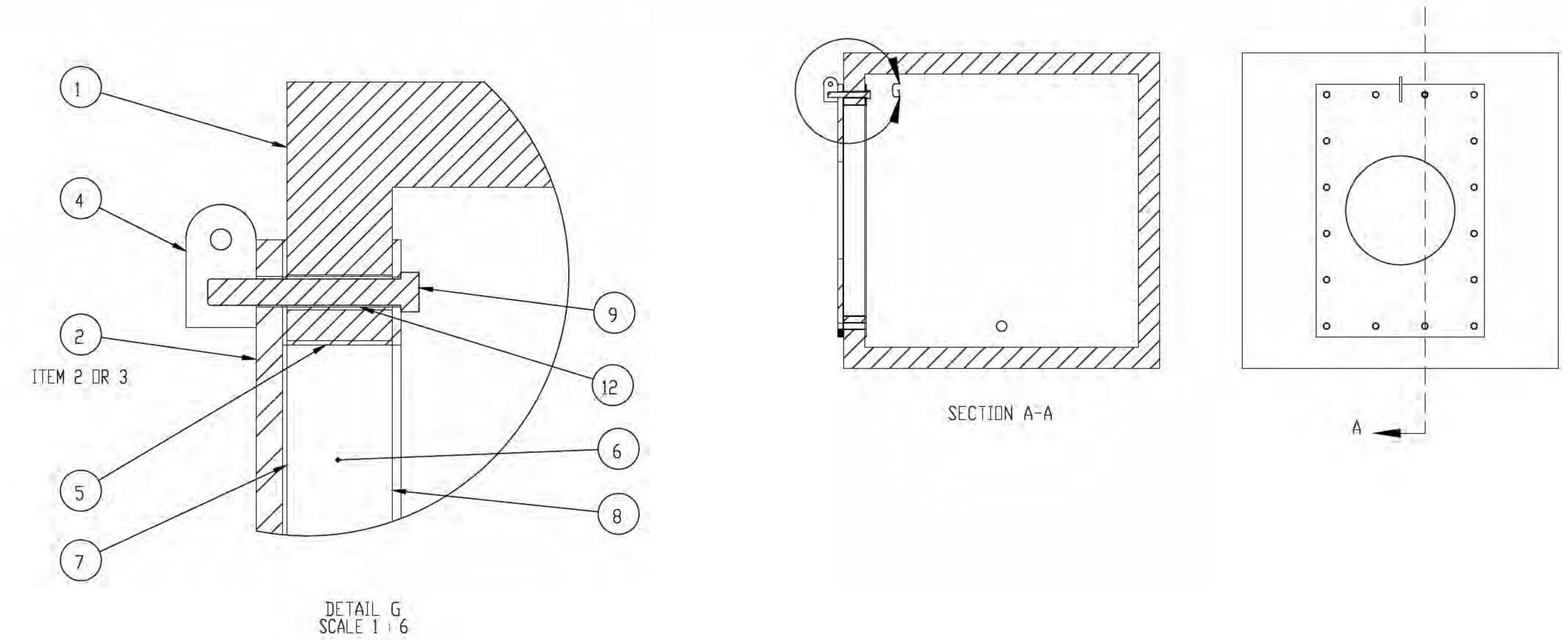


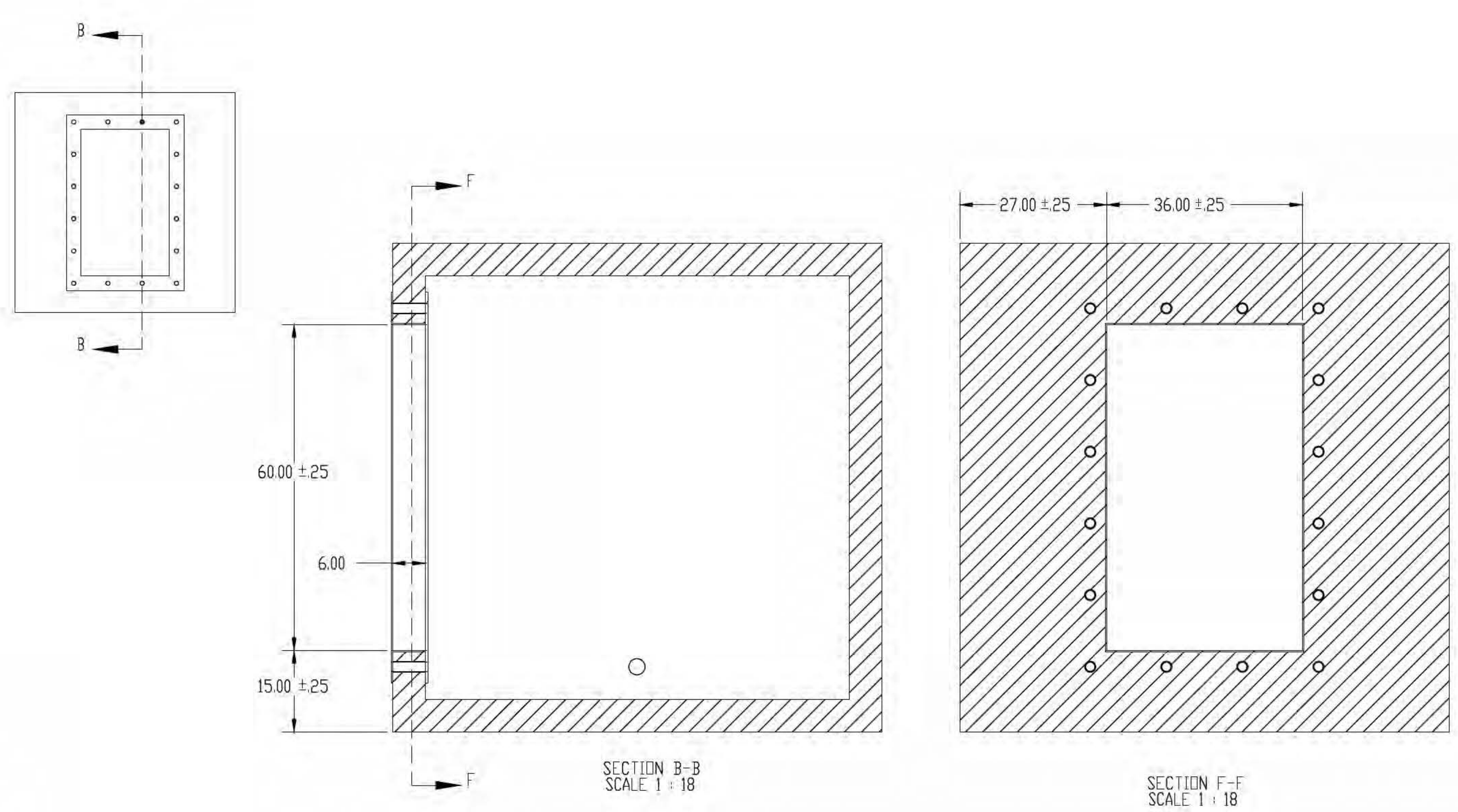
A A-1.0 PLAN, ELEVATIONS AND ISOMETRIC VIEW

ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	CONCRETE	BUNKER STRUCTURE, 7.5' X 7.5' X 7.5', 6.0" WALL THICKNESS ALL AROUND	2
2	DOOR_1	STEEL BLAST DOOR, 31.10" DIAM. HOLE, TEST 1	1
3	DOOR_2	STEEL BLAST DOOR, 15.35" DIAM. HOLE, TEST 2	2
4	DOOR_LIFTING_EYE	LIFTING EYE, DOOR ONLY	3
5	FRAME PLATE 1	TOP AND BOTTOM DOOR FRAME PLATE	4
6	FRAME PLATE 2	RIGHT AND LEFT DOOR FRAME PLATE	4
7	FRAME PLATE 3	OUTSIDE DOOR FRAME PLATE	2
8	FRAME PLATE 4	INSIDE DOOR FRAME PLATE	2
9	BOLT	1.5 – 6 X 11 HEX BOLT, GRADE 5, PLAIN, FASTENAL PART NUMBER: 12685	32
10	WASHER	1.5" FLAT WASHER, THRU HARDENED, HIGH STRENGTH, PLAIN, FASTENAL PART NUMBER: 33809	32
11	NUT	1.5" HEX NUT, GRADE 5, PLAIN, FASTENAL PART NUMBER:12685	32
12	BOLT TUBE	MILD STEEL TUBING, 2" OD X 1/8" WALL THICKNESS	32

*QUANTITIES IN BILL OF MATERIALS ARE TO CONSTRUCT TWO COMPLETE TEST STRUCTURES WITH ONE ADDITIONAL ITEM NUMBER 3.



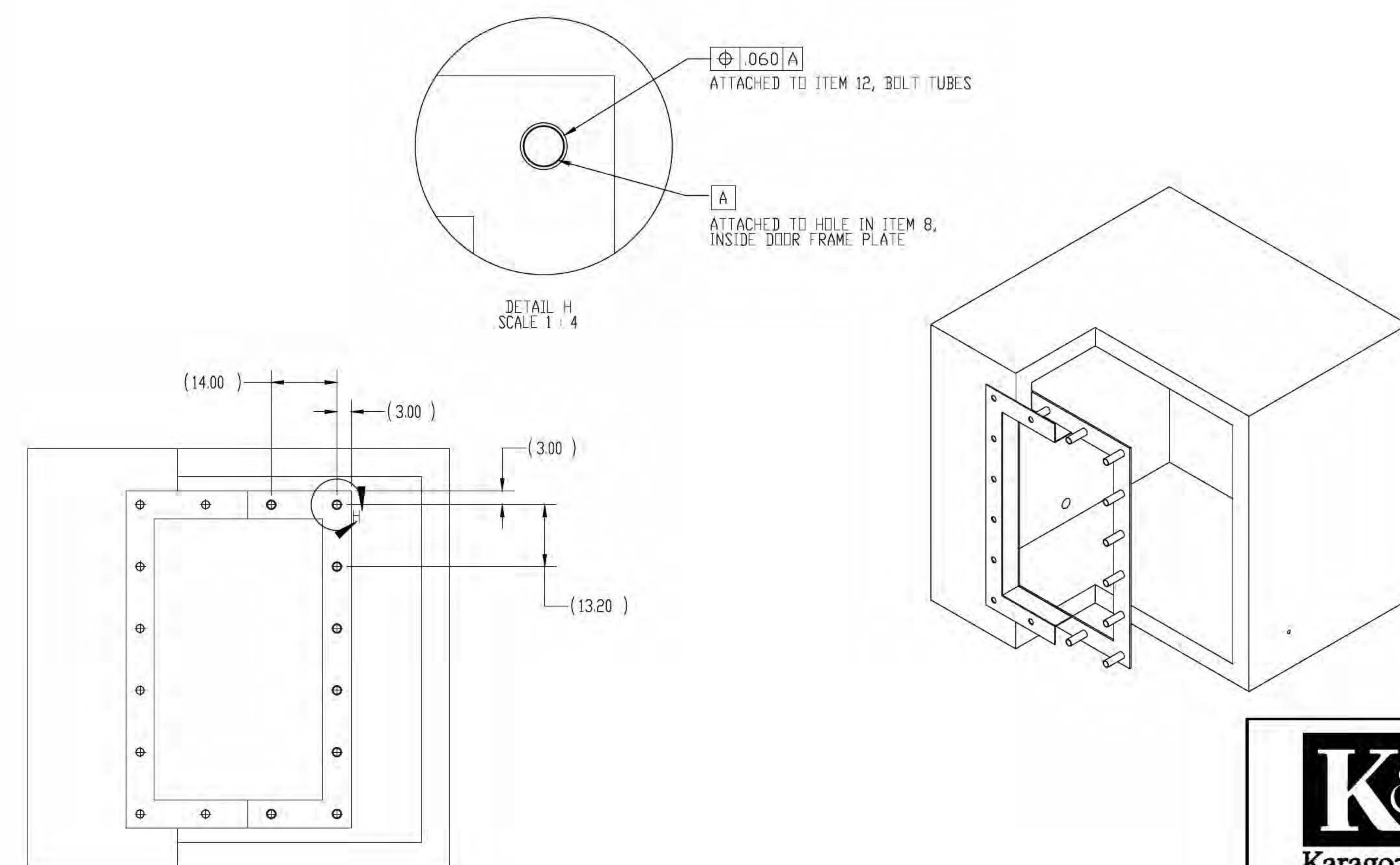
C A-1.0 DOOR DETAILS



NOTES:

1. PROVIDE TWO COMPLETE TEST ARTICLES.
2. THE OUTSIDE OF THE STRUCTURE SHALL BE PAINTED WHITE WITH AN OVERLAYED BLACK GRID PATTERN. THE GRID LINES SHALL BE 2 INCHES WIDE, AND 1.0 FT ON CENTER.

B A-1.0 ELEVATION AND SECTION



D A-1.0 DOOR FRAME DETAILS

K&C Karagozian & Case
Los Angeles
2550 North Hollywood Way, Suite 500
Burbank, CA 91505-5026
Tel: 818-240-1919 Fax: 818-240-4966

K&C JOB NUMBER : SAA1282
A100_SAA1282.DWG

AS-BUILT CONDITIONS SHOWN 05-15-10

NAVFAC

DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
SOUTHWEST DIVISION
SAN DIEGO, CALIFORNIA
TEST STRUCTURE
ARCHITECTURAL DETAILS

A-1.0

July 16, 2012


SEE TEST ARTICLE NOTE 3 ON SHEET S-0.1
ITEM 12 TO ITEMS 7 AND 8, 1/4 CIRCUMFERENCE OF TUBE MIN, 16 PLACES
ITEM 9 TO ITEM 8
ITEMS 5, 6 TO ITEM 7, ALL AROUND DOOR FRAME
ITEMS 5, 6 TO ITEM 8, ALL AROUND DOOR FRAME
ITEM 4 TO ITEM 2 AND 3
ITEM 5 TO ITEM 6, 4 PLACES
DETAIL A SCALE 1 : 4
DETAIL C SCALE 1 : 12
SECTION C-C
DOOR FABRICATION DETAILS
4 MATRL: A36 STEEL
5 MATRL: A36 STEEL
1 MATRL: REINFORCED CONCRETE
6 MATRL: A36 STEEL
SEE TEST ARTICLE NOTE 4 ON SHEET S-0.1
DETAILS
8 MATRL: A36 STEEL
7 ITEM 7 SHALL BE IDENTICAL TO ITEM 8 EXCEPT THE PLATE THICKNESS 1, USED FOR ITEM 7 SHALL BE 0.250" STK.
16 X ø 1.688 ±.030 THRU
12 MATRL: MILD STEEL
ø 2.00 STK
ø 1.75 STK
DETAILS
2 MATRL: A36 STEEL
3 ITEM 3 SHALL BE IDENTICAL TO ITEM 2, EXCEPT THE CENTER HOLE, 2, SHALL HAVE A DIAMETER OF 15.35".
ø 31.10
16 X ø 1.75 ±.03 THRU
DOOR DETAILS
K&C
Karagozian & Case
Los Angeles
2550 North Hollywood Way, Suite 500
Burbank, CA 91505-5026
Tel: 818-240-1919 Fax: 818-240-4966
K&C JOB NUMBER : SAA1282
A200_SAA1282.DWG
AS-BUILT CONDITIONS SHOWN
05-13-10
NAVFAC
DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
SOUTHWEST DIVISION
SAN DIEGO, CALIFORNIA
TEST STRUCTURE
ARCHITECTURAL DETAILS
A-2.0
July 19, 2012

GENERAL NOTES

GENERAL

1. THE CONTRACTOR SHALL VERIFY ALL CONDITIONS AND DIMENSIONS AT THE SITE BEFORE STARTING WORK.
2. TYPICAL DETAILS AND GENERAL NOTES ARE APPLICABLE UNLESS OTHERWISE DETAILED OR NOTED ON THE DRAWINGS. NOTES OR DETAILS ON THE DRAWINGS TAKE PRECEDENCE OVER TYPICAL DETAILS AND GENERAL NOTES.
3. NO STRUCTURAL MEMBERS SHALL BE CUT FOR PIPES, VENTS, DUCTS, AND OTHER SIMILAR OPENINGS, EXCEPT AS DETAILED OR SPECIFIED.
4. FOUNDATION: NO SOILS REPORT PROVIDED. CONTRACTOR TO REMOVE UNSOUND SOILS AT BOTTOM OF EXCAVATION AND REPLACE WITH COMPACTED FILL TO 90% STD DENSITY, MIN. ALL BACKFILL MATERIAL SHALL BE COMPACTED TO 90% STD DENSITY.

CONCRETE

1. CONCRETE IS DESIGNED FOR AND SHALL DEVELOP SPECIFIED 28-DAY STRENGTH, f'_c AS FOLLOWS:
   A. ALL: 7,300 psi ± 500 psi
   B. CEMENT SHALL BE TYPE Ii OR II/V.
   C. CONCRETE SUPPLIER SHALL PROVIDE DOCUMENTATION TO DEMONSTRATE THAT CONCRETE ACHIEVING THE SPECIFIED STRENGTH AT 28 DAYS IS ACHIEVABLE. NOTE THAT CONCRETE STRENGTH SHALL NOT BE BELOW OR EXCEED SPECIFIED STRENGTH BY MORE THAN 500 psi.
   D. ALL CONCRETE SHALL BE INTEGRALLY COLORED WITH COLORS AS NOTED ON THIS SET OF DRAWINGS. STAINING OR PAINTING OF CONCRETE IS NOT AN ACCEPTABLE ALTERNATE. COMPLY WITH PIGMENT MANUFACTURER'S RECOMMENDATIONS TO OBTAIN SPECIFIED COLORS.
2. THE CONTRACTOR SHALL SUBMIT MIX DESIGNS FOR REVIEW PRIOR TO PLACING CONCRETE.

   ALL REBAR, ANCHOR BOLTS, AND OTHER INSERTS SHALL BE FIRMLY SECURED IN PLACE BEFORE CONCRETE IS CAST.
3. DRY PACK SHALL BE OF THE SAME PROPORTIONS USED FOR NEW CONCRETE BUT WITH A MINIMUM OF WATER TO GIVE A CONSISTENCY WHICH WILL BALL IN HAND. IT SHALL BE MIXED INTERMITTENTLY FOR ONE HOUR PRIOR TO PLACING.
4. APPROVED NONSHRINK GROUT MAY BE SUBSTITUTED.

REINFORCING STEEL

1. REINFORCING STEEL SHALL CONFORM TO LATEST ASTM SPECIFICATION A 615 OR A 706, GRADE 60, UNLESS OTHERWISE NOTED.

STRUCTURAL STEEL

1. STRUCTURAL STEEL SHALL CONFORM TO:

A. PLATES	ASTM A36
B. ROLLED SHAPES:	
- W SHAPES	ASTM A992
- S, M, HP AND CHANNEL SHAPES	ASTM A36
- ANGLES	ASTM A36
C. PIPE	ASTM A53, Gr. B
D. TUBES	ASTM A500, Gr. B

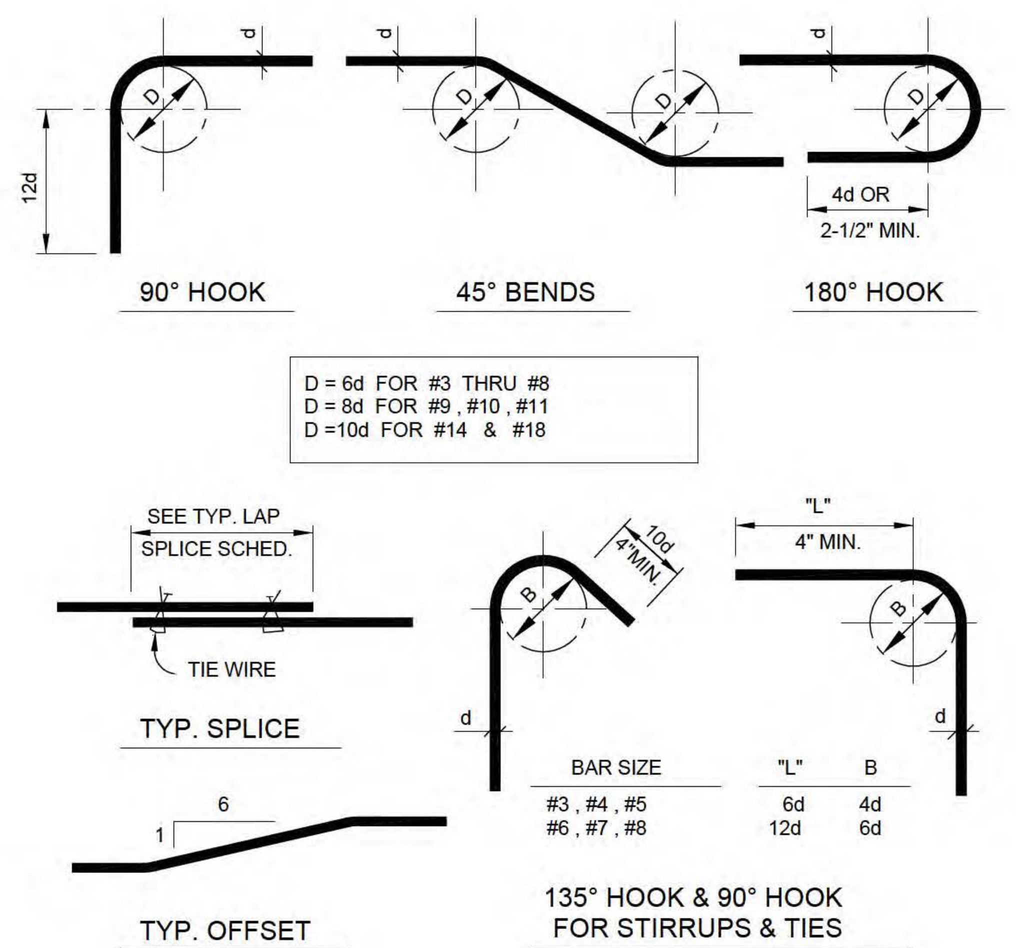
2. MATERIALS AND WORKMANSHIP SHALL CONFORM TO THE LATEST EDITION OF THE SPECIFICATIONS OF THE AMERICAN INSTITUTE OF STEEL CONSTRUCTION.
3. ALL WELDING SHALL BE DONE BY CERTIFIED WELDERS, USING E70XX ELECTRODES. ALL WELDING SHALL CONFORM TO THE LATEST AWS D1.1 STRUCTURAL WELDING CODE.

TEST ARTICLE NOTES

1. IF BUILT OFFSITE, CONTRACTOR SHALL TRANSPORT STRUCTURES TO TEST LOCATION, AND ORIENT TEST STRUCTURE AT TEST SITE FOR A FIRST TEST DATE OF 06 AUGUST 2012.
2. ITEMS 5,6,7,8 AND 12 SHALL BE IN PLACE WHILE CASTING THE STRUCTURE. THESE ITEMS MAY BE WELDED TO THE STEEL REINFORCEMENT OF THE STRUCTURE. (SEE C/A-1.0)
3. ITEM 9, BOLTS, SHALL BE INSERTED THROUGH HOLES IN ITEMS 7 AND 8, INSIDE AND OUTSIDE DOOR PLATES, AND THROUGH ITEM 12, BOLT TUBE. BOLT HEADS SHALL BE 3/8" FILLET WELDED ON A MINIMUM OF 2 OPPOSITE FACES OF THE HEX HEAD TO ITEM 8. ITEM 10, WASHER SHALL NOT BE USED ON THIS INTERFACE. (SEE C/A-1.0)
4. DIMENSIONS ARE FOR REFERENCE ONLY, ACTUAL HEIGHT AND WIDTH OF DOOR OPENING WILL BE DETERMINED BY STEEL DOOR FRAME.
5. ONLY ONE FASTENER SHOWN IN SELECT DETAIL VIEWS SECURING ITEM 2 OR 3 TO REST OF STRUCTURE. (SEE C/A-1.0)
6. ITEMS 2 AND 3 SHALL NOT BE DELIVERED INSTALLED ON TEST STRUCTURE. (SEE C/A-1.0)
7. THE OUTSIDE OF THE STRUCTURE SHALL BE PAINTED WHITE WITH IN OVERLAYED BLACK GRID PATTERN. THE GRID LINES SHALL BE 2 INCHED WIDE, AND 1.0 ft ON CENTER.
8. TWO COMPLETE TEST STRUCTURES SHALL BE FABRICATED.
9. APPROXIMATE TOTAL WEIGHT OF ONE TEST STRUCTURE IS 22,700 lbs.

QUALITY CONTROL

1. THE CONTRACTOR SHALL RETAIN THE SERVICES OF AN INDEPENDENT TESTING LABORATORY TO PERFORM INSPECTIONS OF REINFORCING PLACEMENT AND TO CONFIRM CONCRETE STRENGTH.
2. TWO CONCRETE SAMPLES ARE REQUIRED FOR EACH MIX. ONE SAMPLE PER MIX SHALL BE TESTED FOR COMPRESSIVE STRENGTH ON THE 30TH CURE DAY, AND ONE SAMPLE PER MIX SHALL BE TESTED FOR COMPRESSIVE STRENGTH ON THE FINAL STRUCTURAL TEST DAY, RESULTS SHALL BE REPORTED TO KEVIN FORD, NAWCWD, CODE 476500D.
3. WELD AND INSPECT IAW SUPPLIER STD PRACTICES.



AS-BUILT CONDITIONS SHOWN | 05-13-10

SYM | DESCRIPTION | DATE | APPR

NAVFAC

REGISTERED PROFESSIONAL ENGINEER
JOSEPH VALANCIUS
NO. S3609
STRUCTURAL
State of California

SEAL

SUBMITTED BY

FIRM MEMBER DATE

APPROVED

ACTIVITY - SATISFACTORY TO DATE

APPROVED

FOR COMMANDER NAVFAC DATE

DES KJC	DR
CHK PL	QC

DESIGNER OF RECORD
REVIEWED BY
QC
PROJECT MANAGER
FIRE PROTECTION
BLT LEADER
AFT LEADER

DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
SAN DIEGO, CALIFORNIA
SOUTHWEST DIVISION

TEST STRUCTURE

GENERAL NOTES & TYPICAL DETAILS

K&C
Karagozian & Case

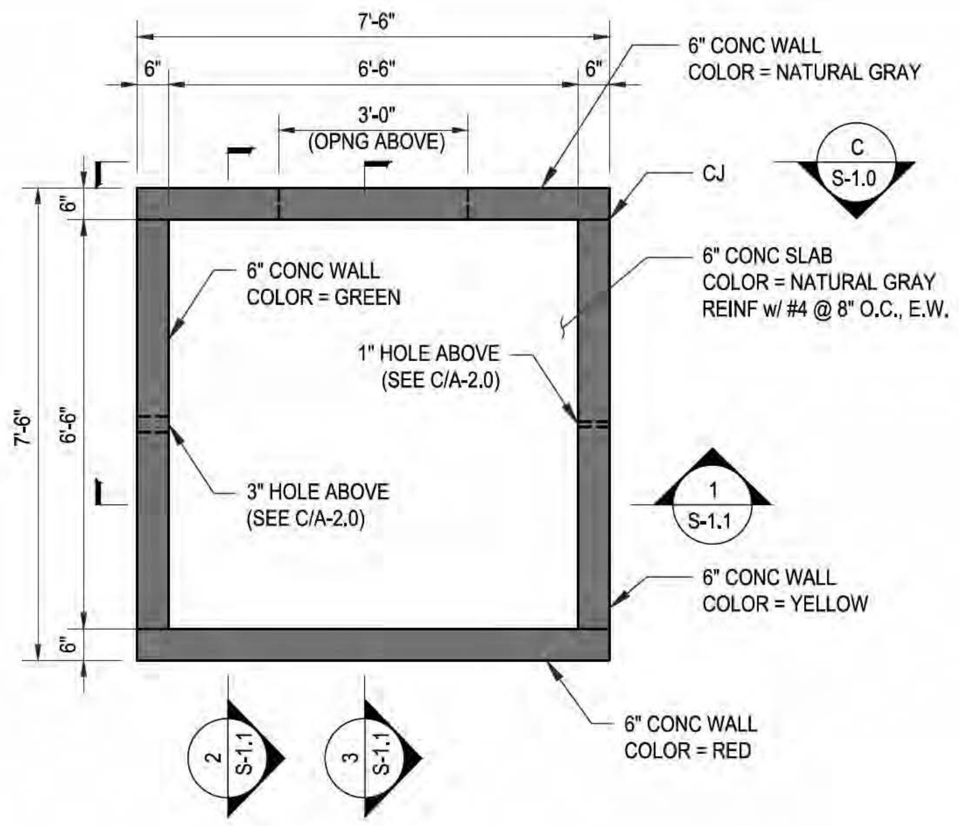
Los Angeles
2550 North Hollywood Way, Suite 500
Burbank, CA 91505-5026
Tel: 818-240-1919 Fax: 818-240-4966

K&C JOB NUMBER : SAA1282
S001_SAA1282.DWG

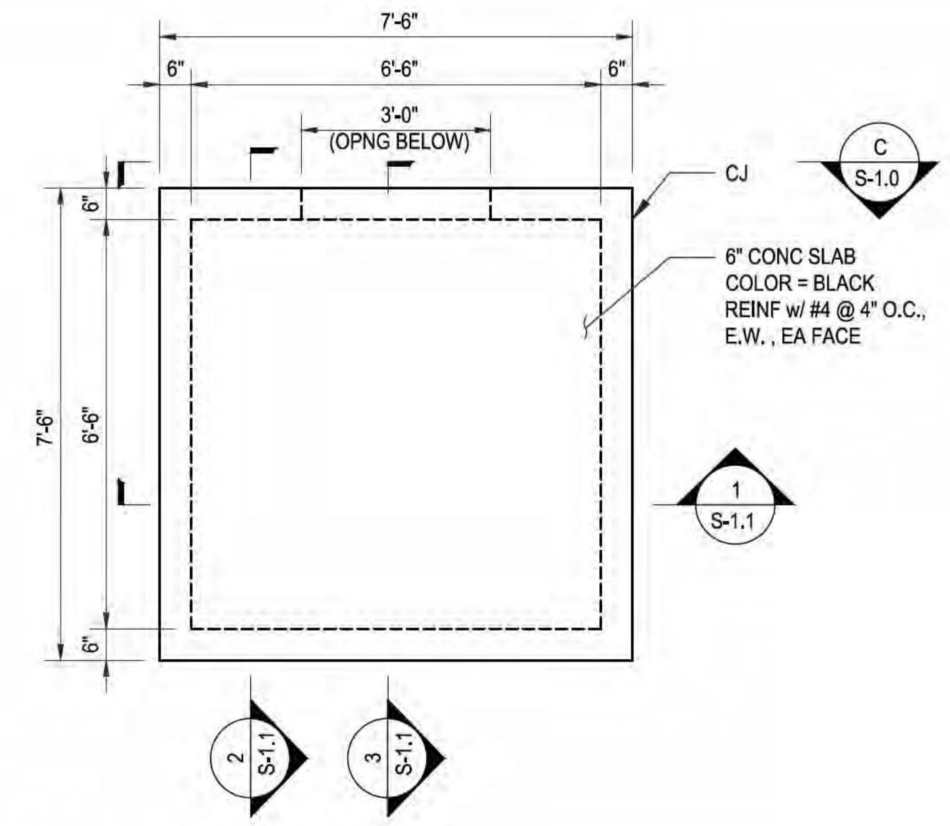
CODE ID. NO. 80091	SIZE E1
SCALE:	
STA. DWG. NO.	
STA. PROJ. NO.	
SPEC. NO.	
CONSTR. CONTR. NO.	
NAVFAC DRAWING NO.	IR DRAWING NO.
SHEET OF	

S-0.1

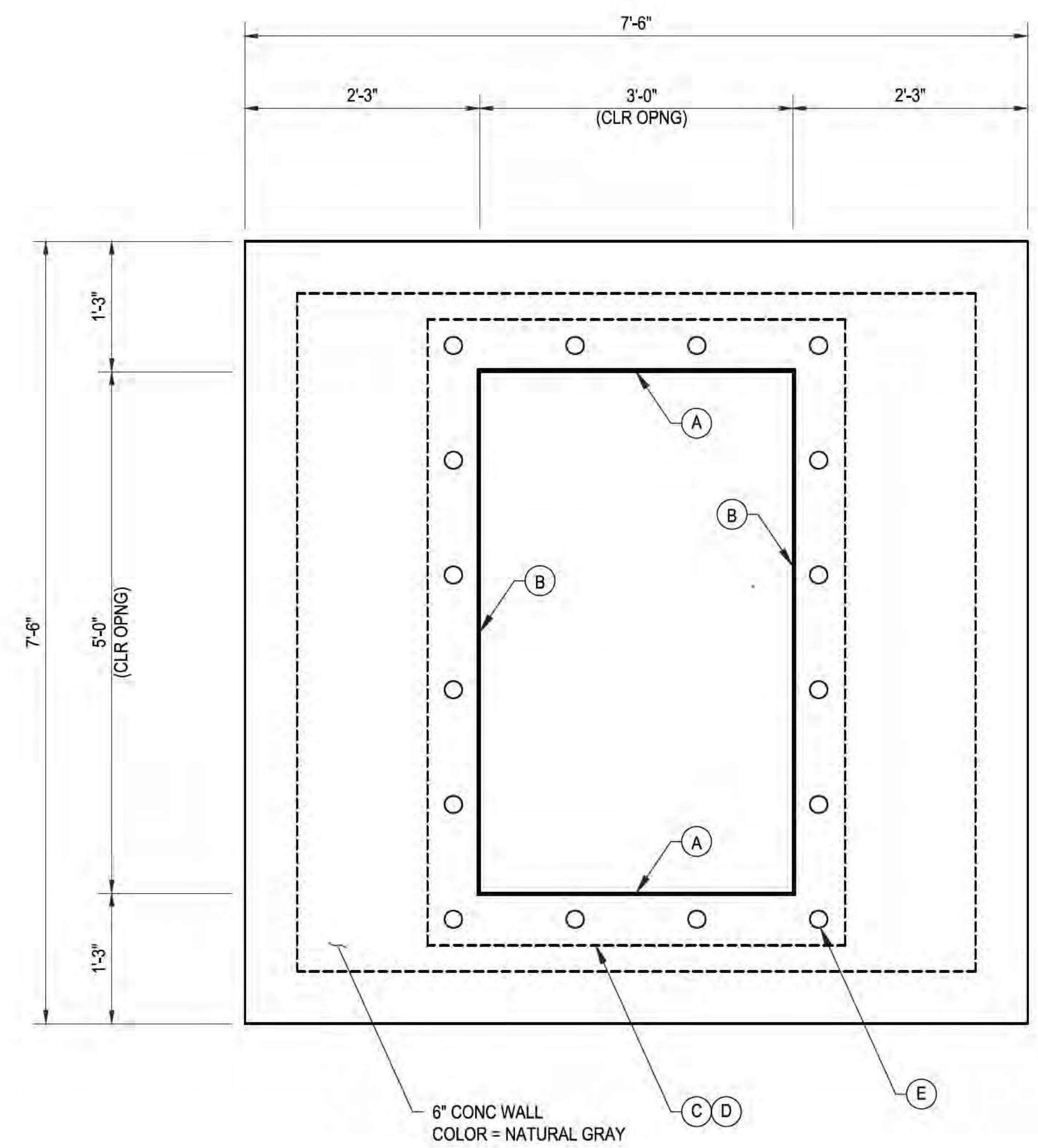
July 19, 2012



A FOUNDATION / FLOOR PLAN
S-1.0 SCALE: 1/2 " = 1'-0"



B ROOF PLAN
S-1.0 SCALE: 1/2 " = 1'-0"



SCHEDULE	
MARK	DESCRIPTION
A	¼" x 6"x36½" STL PL
B	¼" x 6"x60" STL PL
C	½" STL PL (FAR SIDE)
D	¼" STL PL (NEAR SIDE NOT SHOWN FOR CLARITY)
E	STL TUBE (SEE C/A-1.0 & B/A-2.0)

C WALL ELEVATION
S-1.0 SCALE: 1 " = 1'-0"

AS-BUILT CONDITIONS SHOWN 05-13-10

SYM DESCRIPTION DATE APPR

NAVFAC

REGISTERED PROFESSIONAL ENGINEER JOSEPH VALANCIUS NO. S3609 STRUCTURAL State of California

SEAL

SUBMITTED BY

FIRM MEMBER DATE

APPROVED

ACTIVITY - SATISFACTORY TO DATE

APPROVED

FOR COMMANDER NAVFAC DATE

DES KJC DR

CHK PL QC

DESIGNER OF RECORD

REVIEWED BY

QC

PROJECT MANAGER

FIRE PROTECTION

BLT LEADER

AFT LEADER

DEPARTMENT OF THE NAVY

NAVAL FACILITIES ENGINEERING COMMAND

SOUTHWEST DIVISION

SAN DIEGO, CALIFORNIA

TEST STRUCTURE

PLANS AND DETAILS

K&C

Karagozian & Case

Los Angeles
2550 North Hollywood Way, Suite 500
Burbank, CA 91505-5026
Tel: 818-240-1919 Fax: 818-240-4966

K&C JOB NUMBER : SAA1282

S100_SAA1282.DWG

CODE ID. NO. 80091 SIZE E1

SCALE:

STA. DWG. NO.

STA. PROJ. NO.

SPEC. NO.

CONSTR. CONTR. NO.

NAVFAC DRAWING NO. IR DRAWING NO.

SHEET OF

S-1.0

July 16, 2012

7'-6"
6'-6"
6"
1" CLR
3/4" CLR
2 1/2" CLR
CJ (TYP)
#4 x 88" BARS @ 4" O.C., E.W., T&B
#4 x 76" HORIZ BARS @ 4" O.C., EA. FACE
#4 x 82" VERT BARS @ 4" O.C.
#4 @ 4" O.C.
#4 x 88" BARS @ 8" O.C., E.W.
1 DETAIL S-1.1 SCALE: 1" = 1'-0"
2- #4 HORIZ BARS A&B DOOR OPNG
#4 x 88" @ 4" O.C., E.W., T&B
#4 HORIZ BARS @ 4" O.C., EA SIDE OF DOOR OPNG
5- #4 x 88" VERT BARS EA SIDE OF DOOR OPNG
5-#4 VERT BARS @ 4" O.C., EA SIDE OF DOOR OPNG
#4 HORIZ BARS @4" O.C., EA SIDE OF DOOR OPNG
2- #4 x 88 HORIZ BARS @4" O.C., A&B DOOR OPNG
#4 @ 8" O.C., E.W.
#4 HORIZ BARS @ 4" O.C.
#4 x 88" HORIZ BARS @ 4" O.C.
#4 x 88" VERT BARS @ 4" O.C.
#4 VERT BARS @ 4" O.C.
2 DETAIL S-1.1 SCALE: 1" = 1'-0"
NOTE: STEEL PLATES @ OPNG ARE NOT SHOWN. SEE / FOR ADD'L INFO.
9- #4 DOWELS @ 4"
9- #4 BARS @ 4"
SEE SECTION 2/ S-1.1 FOR ADD'L INFO
3 DETAIL S-1.1 SCALE: 1" = 1'-0"
1'-9"
3'-0" OPNG
#4 HORIZ BARS @ 4" O.C. EA SIDE OF DOOR OPNG
#4 x 76" HORIZ BARS @ 4" O.C. EA. FACE
#4 x 88" HORIZ BARS @ 4" O.C.
#4 HORIZ BARS @ 4" O.C.
4 PLAN DETAIL S-1.1 SCALE: 1" = 1'-0"
AS-BUILT CONDITIONS SHOWN
NAVFAC
K&C Karagozian & Case
Los Angeles
2550 North Hollywood Way, Suite 500
Burbank, CA 91505-5026
Tel: 818-240-1919 Fax: 818-240-4966
K&C JOB NUMBER : SAA1282
S101_SAA1282.DWG
DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
SOUTHWEST DIVISION
SAN DIEGO, CALIFORNIA
TEST STRUCTURE
DETAILS
S-1.1
July 16, 2012

CHINA LAKE
TEST STRUCTURE

INDEX OF DRAWINGS	
SHEET	DESCRIPTION
T-1.0	COVER SHEET & DRAWING INDEX
A-1.0	ARCHITECTURAL DETAILS
A-2.0	ARCHITECTURAL DETAILS
S-0.1	GENERAL NOTES AND TYPICAL DETAILS
S-1.0	PLAN & DETAILS
S-1.1	DETAILS

AS-BUILT CONDITIONS SHOWN 05-13-10

SYM | DESCRIPTION | DATE | APPR

NAVFAC

REGISTERED PROFESSIONAL ENGINEER JOSEPH VALANCIUS NO. S3609 STRUCTURAL State of California

SEAL

SUBMITTED BY

FIRM MEMBER DATE

APPROVED

ACTIVITY - SATISFACTORY TO DATE

APPROVED

FOR COMMANDER NAVFAC DATE

DES KJC	DR
CHK PL	QC
DESIGNER OF RECORD	
REVIEWED BY	
QC	
PROJECT MANAGER	
FIRE PROTECTION	
BLT LEADER	
AFT LEADER	

DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
SOUTHWEST DIVISION
SAN DIEGO, CALIFORNIA

TEST STRUCTURE

K&C
Karagozian & Case
Los Angeles
2550 North Hollywood Way, Suite 500
Burbank, CA 91505-5026
Tel: 818-240-1919 Fax: 818-240-4966

K&C JOB NUMBER : SAA1282
T100_SAA1282.DWG

CODE ID. NO. 80091	SIZE E1
SCALE:	
STA. DWG. NO.	
STA. PROJ. NO.	
SPEC. NO.	
CONSTR. CONTR. NO.	
NAVFAC DRAWING NO.	IR DRAWING NO.
SHEET OF	

T-1.0

July 16, 2012

Appendix I-B

CONCRETE MIX RATIOS AND STRENGTH DATA FOR TESTS 1 THROUGH 4

(The contents of this appendix are reproduced in facsimile.)

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ROBERTSON'S

ROCK * SAND * BASE MATERIALS
READY MIX CONCRETE

QUALITY CONTROL - TECHNICAL SERVICES

FACSIMILE MESSAGE

Telephone: (951) 685-2200 ext 6381
FAX# **(951) 280-1429**
Email : robbie@rrmca.com

To:	HAL HAYS CONSTRUCTION	From:	ROBERTSON'S READY MIX
Attn:	MIGUEL DURAN	Attn:	ROBBI STANOFF
EMAIL:	mduran@halhays.com	Fax:	**(951) 280-1429**
Date:	08/16/2012	No. of Pages (INCLUDING COVER PAGE)	6 + Certs

Subject: MIX DESIGN AND STRENGTH DATA FOR CONCRETE BUNKERS, 32342 DUNLAP BLVD., YUCAIPA

Message: *Per your request*

ROBERTSON'S

ROCK * SAND * BASE MATERIALS
READY MIX CONCRETE

REGISTERED PROFESSIONAL ENGINEER MICHAEL M. OROZCO NO. 61055 EXP. 12/31/12 CIVIL STATE OF CALIFORNIA

*****Color is optional - please state color and brand when scheduling concrete delivery*****

Date: 08/16/2012

Concrete Mix Design #: LB080021

Project:	**Concrete Bunkers, 32342 Dunlap Blvd., Yucaipa**		
Contractor:	**Hal Hays Construction**		
Description:	*7000 psi 3/8" Mix with ADVA and Recover*		
Strength (f'c):	7000 psi	*W/C ratio:*	0.35
Slump:	6 " (+/- 1")	*Sack Content:*	9.60 sk.
Max. Size of Agg.:	3/8 "	*Gal/sk.:*	3.96
Pump Type:	Trailer Pump - 3" Line	*Un. Wt.:*	149.0

ALL CONCRETE IS MIXED AND DELIVERED IN ACCORDANCE WITH ASTM C-94

Aggregate Weights are SSD; Moisture in Aggregates Must be Considered When Determining Total Mix Water

Contents:		MIX DESIGN PROPORTION			
		Batch Wt.	%used	Sp. Gr.	Volume
Cement (ASTM C-150)		748	83	3.15	3.81
Fly Ash-Class F (ASTM C-618)		154	17	2.33	1.06
Sand		1475	53	2.62	9.03
1-1/2" x 3/4"		0	0	2.67	0.00
1" x #4		0	0	2.65	0.00
3/8" x #8		1328	47	2.65	8.04
Water	38.0 gal.	316.5			5.07
Entrapped Air	0 %				0.00
	Wt.=	4022		Vol. =	27.00

ADMIXTURES :

WRDA 64	(ASTM C-494)	3.0 oz./cwt.	27.1 oz.	
ADVA	(ASTM C-494)	3 to 9 oz./cwt.	25 to 76 oz range	
Recover - to delay set 1 hr.		**9.0 oz./yd.**	**9.0 oz./yd.**	

Note: Dosage rate of Adva shall be adjusted to achieve the design slump.

*****Optional Color - Davis Brick Red - D160C***

Size	%	AGGREGATE GRADATIONS 2"	1 1/2"	1"	3/4"	1/2"	3/8"	No 4	No 8	No 16	No 30	No 50	No 100	No 200
1 1/2"	0	100	95	33	7	3	1	0	0	0	0	0	0	0
1"	0	100	100	95	70	38	12	1	0	0	0	0	0	0
3/8"	47	100	100	100	100	100	96	18	2	1	1	0	0	0
WCS	53	100	100	100	100	100	100	98	77	60	39	18	6	2
Combined	100	100	100	100	100	100	98	60	42	32	21	10	3	1

Sand Source : Robertson's Redlands
Rock Source : Robertson's Redlands
Cement : Portland Cement Type II/V
Flyash: Class F

Aggregates meet ASTM C-33

(951) 685-2200 ext 6381 *P.O. Box 3600 Corona, CA 92878* *Fax (951) 280-1429*

ROBERTSON'S

ROCK * SAND * BASE MATERIALS
READY MIX CONCRETE

PROFESSIONAL ENGINEER
MICHAEL M. OROZCO
NO. 61055
EXP. 12/31/12
CIVIL
STATE OF CALIFORNIA

Color is optional - please state color and brand when scheduling concrete delivery

Date: 08/16/2012

Concrete Mix Design #: LB080021

Project: **Concrete Bunkers, 32342 Dunlap Blvd., Yucaipa**
Contractor: **Hal Hays Construction**
Description: 7000 psi 3/8" Mix with ADVA and Recover
Strength (f'c): 7000 psi
Slump: 6 " (+/- 1")
Max. Size of Agg.: 3/8 "
Pump Type: Trailer Pump - 3" Line

W/C ratio: 0.35
Sack Content: 9.60 sk.
Gal/sk.: 3.96
Un. Wt.: 149.0

ALL CONCRETE IS MIXED AND DELIVERED IN ACCORDANCE WITH ASTM C-94

Aggregate Weights are SSD; Moisture in Aggregates Must be Considered When Determining Total Mix Water

Contents:		Batch Wt.	%used	Sp. Gr.	Volume
		MIX DESIGN PROPORTION			
Cement (ASTM C-150)		748	83	3.15	3.81
Fly Ash-Class F (ASTM C-618)		154	17	2.33	1.06
Sand		1475	53	2.62	9.03
1-1/2" x 3/4"		0	0	2.67	0.00
1" x #4		0	0	2.65	0.00
3/8" x #8		1328	47	2.65	8.04
Water	38.0 gal.	316.5			5.07
Entrapped Air	0 %				0.00
	Wt.=	4022		Vol. =	27.00

ADMIXTURES :

WRDA 64	(ASTM C-494)	3.0	oz./cwt.	27.1 oz.
ADVA	(ASTM C-494)	3 to 9	oz./cwt.	25 to 76 oz range
Recover - to delay set 1 hr.		**9.0**	**oz./yd.**	**9.0 oz./yd.**

Note: Dosage rate of Adva shall be adjusted to achieve the design slump.

***Optional Color - Davis Graphite Black - D8084E**

		AGGREGATE GRADATIONS												
Size	%	2"	1 1/2"	1"	3/4"	1/2"	3/8"	No 4	No 8	No 16	No 30	No 50	No 100	No 200
1 1/2"	0	100	95	33	7	3	1	0	0	0	0	0	0	0
1"	0	100	100	95	70	38	12	1	0	0	0	0	0	0
3/8"	47	100	100	100	100	100	96	18	2	1	1	0	0	0
WCS	53	100	100	100	100	100	100	98	77	60	39	18	6	2
Combined	100	100	100	100	100	100	98	60	42	32	21	10	3	1

Sand Source : Robertson's Redlands
Rock Source : Robertson's Redlands
Cement : Portland Cement Type II/V
Flyash: Class F

Aggregates meet ASTM C-33

(951) 685-2200 ext 6381 P.O. Box 3600 Corona, CA 92878 Fax (951) 280-1429

ROBERTSON'S

ROCK * SAND * BASE MATERIALS
READY MIX CONCRETE

REGISTERED PROFESSIONAL ENGINEER
MICHAEL M. OROZCO
NO. 61055
EXP. 12/31/12
CIVIL
STATE OF CALIFORNIA

Color is optional - please state color and brand when scheduling concrete delivery

Date: 08/16/2012

Concrete Mix Design #: LB080021

Project:	**Concrete Bunkers, 32342 Dunlap Blvd., Yucaipa**
Contractor:	**Hal Hays Construction**
Description:	7000 psi 3/8" Mix with ADVA and Recover

Strength (f'c):	7000 psi	*W/C ratio:*	0.35
Slump:	6 " (+/- 1")	*Sack Content:*	9.60 sk.
Max. Size of Agg.:	3/8 "	*Gal/sk.:*	3.96
Pump Type:	Trailer Pump - 3" Line	*Un. Wt.:*	149.0

ALL CONCRETE IS MIXED AND DELIVERED IN ACCORDANCE WITH ASTM C-94

Aggregate Weights are SSD; Moisture in Aggregates Must be Considered When Determining Total Mix Water

Contents:			**MIX DESIGN PROPORTION**			
			Batch Wt.	%used	Sp. Gr.	Volume
Cement (ASTM C-150)			748	83	3.15	3.81
Fly Ash-Class F (ASTM C-618)			154	17	2.33	1.06
Sand			1475	53	2.62	9.03
1-1/2" x 3/4"			0	0	2.67	0.00
1" x #4			0	0	2.65	0.00
3/8" x #8			1328	47	2.65	8.04
Water	38.0	gal.	316.5			5.07
Entrapped Air	0	%				0.00
	Wt.=		4022		Vol. =	27.00

ADMIXTURES :

WRDA 64	(ASTM C-494)	3.0	oz./cwt.	27.1 oz.
ADVA	(ASTM C-494)	3 to 9	oz./cwt.	25 to 76 oz range
Recover - to delay set 1 hr.		**9.0**	**oz./yd.**	**9.0 oz./yd.**

Note: Dosage rate of Adva shall be adjusted to achieve the design slump.

Optional Color - Target Yellow

		AGGREGATE GRADATIONS												
Size	%	2"	1 1/2"	1"	3/4"	1/2"	3/8"	No 4	No 8	No 16	No 30	No 50	No 100	No 200
1 1/2"	0	100	95	33	7	3	1	0	0	0	0	0	0	0
1"	0	100	100	95	70	38	12	1	0	0	0	0	0	0
3/8"	47	100	100	100	100	100	96	18	2	1	1	0	0	0
WCS	53	100	100	100	100	100	100	98	77	60	39	18	6	2
Combined	100	100	100	100	100	100	98	60	42	32	21	10	3	1

Aggregates meet ASTM C-33

Sand Source :	Robertson's Redlands
Rock Source :	Robertson's Redlands
Cement :	Portland Cement Type II/V
Flyash:	Class F

(951) 685-2200 ext 6381 P.O. Box 3600 Corona, CA 92878 Fax (951) 280-1429

ROBERTSON'S

ROCK * SAND * BASE MATERIALS
READY MIX CONCRETE

REGISTERED PROFESSIONAL ENGINEER MICHAEL M. OROZCO NO. 61055 EXP. 12/31/12 CIVIL STATE OF CALIFORNIA

Color is optional - please state color and brand when scheduling concrete delivery

Date: 08/16/2012

Concrete Mix Design #: LB080021

Project:	**Concrete Bunkers, 32342 Dunlap Blvd., Yucaipa**		
Contractor:	**Hal Hays Construction**		
Description:	7000 psi 3/8" Mix with ADVA and Recover		
Strength (f'c):	7000 psi	W/C ratio:	0.35
Slump:	6 " (+/- 1")	Sack Content:	9.60 sk.
Max. Size of Agg.:	3/8 "	Gal/sk.:	3.96
Pump Type:	Trailer Pump - 3" Line	Un. Wt.:	149.0

ALL CONCRETE IS MIXED AND DELIVERED IN ACCORDANCE WITH ASTM C-94

Aggregate Weights are SSD; Moisture in Aggregates Must be Considered When Determining Total Mix Water

Contents:		Batch Wt.	%used	Sp. Gr.	Volume
		MIX DESIGN PROPORTION			
Cement (ASTM C-150)		748	83	3.15	3.81
Fly Ash-Class F (ASTM C-618)		154	17	2.33	1.06
Sand		1475	53	2.62	9.03
1-1/2" x 3/4"		0	0	2.67	0.00
1" x #4		0	0	2.65	0.00
3/8" x #8		1328	47	2.65	8.04
Water	38.0 gal.	316.5			5.07
Entrapped Air	0 %				0.00
	Wt.=	4022		Vol. =	27.00

ADMIXTURES :

WRDA 64 (ASTM C-494)	3.0 oz./cwt.	27.1 oz.	
ADVA (ASTM C-494)	3 to 9 oz./cwt.	25 to 76 oz range	
Recover - to delay set 1 hr.	**9.0 oz./yd.**	**9.0 oz./yd.**	

Note: Dosage rate of Adva shall be adjusted to achieve the design slump.

***Optional Color - Sage Green**

AGGREGATE GRADATIONS

Size	%	2"	1 1/2"	1"	3/4"	1/2"	3/8"	No 4	No 8	No 16	No 30	No 50	No 100	No 200
1 1/2"	0	100	95	33	7	3	1	0	0	0	0	0	0	0
1"	0	100	100	95	70	38	12	1	0	0	0	0	0	0
3/8"	47	100	100	100	100	100	96	18	2	1	1	0	0	0
WCS	53	100	100	100	100	100	100	98	77	60	39	18	6	2
Combined	100	100	100	100	100	100	98	60	42	32	21	10	3	1

Sand Source : Robertson's Redlands
Rock Source : Robertson's Redlands
Cement : Portland Cement Type II/V
Flyash: Class F

Aggregates meet ASTM C-33

(951) 685-2200 ext 6381 P.O. Box 3600 Corona, CA 92878 Fax (951) 280-1429

Compressive Strength Results
Mix # LB080021

Project	**Concrete Bunkers, 32342 Dunlap Blvd., Yucaipa**	Date:	08/16/2012
Subject	Mix design submittal		

MSA, in.:	3/8"	Source of Aggregate:	Robertson's Redlands
EqSack:	9.6	Cement:	Mitsubishi
		Mineral Admixture:	None
		Chemical Admixture:	WRDA - 64, ADVA and Recover

Set #	Cast Date	28 day 1	28 day 2	28 Day Avg	Range	In Co Var	Cum Avg	Cum Std Dev	Cum CoVar	Moving Three (3)
1	06/15/2009	8260	8140	8200	120		8200			
2	06/17/2009	7470	7580	7525	110		7863	477.3	6.1	
3	06/23/2009	8520	8340	8430	180		8052	470.4	5.8	8052
4	06/26/2009	8030	7930	7980	100		8034	385.7	4.8	7978
5	07/06/2009	7880	7650	7765	230		7980	355.0	4.4	8058
6	07/08/2009	8500	8370	8435	130		8056	367.9	4.6	8060
7	07/14/2009	8550	8420	8485	130		8117	372.9	4.6	8228
8	07/16/2009	7780	7910	7845	130		8083	358.4	4.4	8255
9	07/23/2009	7720	7850	7785	130		8050	349.7	4.3	8038
10	07/23/2009	8230	8100	8165	130		8062	331.7	4.1	7932
11	07/23/2009	7870	7680	7775	190		8035	326.3	4.1	7908
12	07/23/2009	8200	8030	8115	170		8042	312.0	3.9	8018
13	07/23/2009	8040	8060	8050	20		8043	298.7	3.7	7980
14	07/23/2009	7820	7640	7730	180		8020	298.9	3.7	7965
15	07/27/2009	7990	7840	7915	150		8013	289.3	3.6	7898
16	07/28/2009	8070	8130	8100	60		8019	280.3	3.5	7915
17	07/29/2009	8190	8170	8180	20		8028	274.2	3.4	8065
18	07/30/2009	8040	7880	7960	160		8024	266.5	3.3	8080
19	07/30/2009	7060	7110	7085	50		7975	337.0	4.2	7742
20	07/30/2009	8090	7960	8025	130		7978	328.2	4.1	7690
21	07/30/2009	8500	8570	8535	70		8004	342.2	4.3	7882
22	07/30/2009	8250	8100	8175	150		8012	336.0	4.2	8245
23	08/04/2009	7050	7030	7040	20		7970	385.7	4.8	7917
24	08/14/2009	7460	7340	7400	120		7946	394.8	5.0	7538
25										
26										
27										
28										
29										
30										

Spec'd *f'c* = 7000 psi @ 28 days

Reg'd *f'cr* = 7571 psi, the larger of [1] or[2] Below

Number of tests	24
Modification Factor (K)	1.08
Maximum	8535
Minimum	7040
Standard Deviation (s)	394.8
Coefficient of variation	5.0

[1]	*f'cr* = *f'c* +1.34ks =	7000	+ (1.34 *	1.08	*	394.8	)	7571
[2]	*f'cr* = *f'c* +*2.33* ks - 500 =	7000	+ (2.33 *	1.08	*	394.8	) - 500	7493

MITSUBISHI CEMENT CORPORATION

CERTIFICATE OF TEST

Source: Cushenbury Plant **Portland Cement - Type I, II, II (MH) & V** **Date: 8/7/2012**

ASTM designation: C 150 - 09 for Type I, II, II (MH) & V low alkali Cement	Production Period	
CALTRANS Specification: Section 90 – 2.01 for Type II modified and V.	From:	7/1/2012
NDOT Specification: Section 701 – 3.01 for Type II and V.	To:	7/31/2012
AZDOTSpecifications Subsection 1006-2.01 for Type II and V.		

Chemical Composition:

	ASTM C-150 Limits				Test
	Type I	Type II	Type V		Results
Silicon Dioxide (SiO_2), %	----	20.0	----	Min.	21.0
Aluminum Oxide (Al_2O_3), %	----	6.0	----	Max.	3.8
Ferric Oxide (Fe_2O_3), %	----	6.0	----	Max.	3.8
Calcium Oxide (CaO), %	----	----	----		62.9
Magnesium Oxide (MgO), %	6.0	6.0	6.0	Max.	2.9
Sulfur Trioxide (SO_3), %	3.0	3.0	2.3	Max.	2.0
Loss on Ignition (LOI), %	3.0	3.0	3.0	Max.	2.1
Insoluble Residue	0.75	0.75	0.75	Max.	0.36
Total Alkali (%Na_2O + 0.658 * %K_2O)	0.60	0.60	0.60	Max.	0.50
Tricalcium Silicate (C_3S), [b] %	----	----	----		54
Tricalcium Aluminate (C_3A), [b] %	----	8	5	Max.	3
$C_4AF + 2*C_3A$ [b]	----	----	25	Max.	18
$C_3S + 4.75*C_3A$ [b]	----	100	----	Max.	70
CO_2, %	----	----	----		1.6
Limestone, %	5.0	5.0	5.0	Max.	3.8
$CaCO_3$ Limestone Purity, %	70	70	70	Min.	92

PHYSICAL RESULTS:

	Type I	Type II	Type V		Results
Blaine Fineness (m^2/kg)	260 / ---	260 / 430	260 / ---	Min / Max	375
325 Mesh (% Passing)	----	----	----		97.0
Autoclave Expansion (%)	0.80	0.80	0.80	Max.	0.06
Time of Set Initial Vicat (minutes)	45 / 375	45 / 375	45 / 375	Min. / Max.	154
Air Entrainment (% Volume)	12	12	12	Max.	6.2
Heat of Hydration at 7 Days (kJ/kg)	----	----	----	[a]	346
False Set, %	50	50	50	Min.	92
Color, (L value)	----	----	----		55

Compressive Strength Test:

		Type I		Type II		Type V			MPA	PSI
		MPA	psi	MPA	psi	MPA	psi			
1 Day		----	----	----	----	----	----		9.5	1381
3 Day		12.0	1740	10.0	1450	8.0	1160	Min.	20.7	3003
7 Day		19.0	2760	17.0	2470	15.0	2180	Min.	29.3	4256
28 Day	June 2012	----	----	----	----	21.0	3050	Min.	41.3	5993

This cement has been sampled and tested in accordance with ASTM standard methods and procedures. All tests results are certified to comply with the type specification designated above. No other warranty is made or implied. We are not responsible for improper use or workmanship. [a] For information only. [b] Adjusted per ASTM C150 A1.6

MITSUBISHI CEMENT CORPORATION
Cushenbury plant

Tom Gepford

Tom Gepford
Quality Control Manager

MITSUBISHI CEMENT CORPORATION

CERTIFICATE OF TEST

Source: Cushenbury Plant **Portland Cement - Type I, II, II (MH) & V** **Date: 8/7/2012**

ASTM designation: C 150 - 09 for Type I, II, II (MH) & V low alkali Cement	**Production Period**
CALTRANS Specification: Section 90 – 2.01 for Type II modified and V.	**From: 7/1/2012**
NDOT Specification: Section 701 – 3.01 for Type II and V.	**To: 7/31/2012**
AZDOTSpecifications Subsection 1006-2.01 for Type II and V.	

Additional Data

Limestone Addition

% Addition:	3.8
SiO2 (%)	4.3
Al_2O_3 (%)	1.1
Fe_2O_3 (%)	0.4
CaO (%)	49.9
SO_3 (%)	0.0

Base Cement Phase Composition

C_3S	56
C_2S	19
C_3A	4
C_4AF	12

We certify that the above described data represents the material used in the cement manufactured during the production period indicated.

MITSUBISHI CEMENT CORPORATION
Cushenbury plant

Tom Gepford

Tom Gepford
Quality Control Manager

HEADWATERS RESOURCES

Adding Value to Energy ™

ASTM C618 / AASHTO M295 Testing of
Pomona Terminal Fly Ash

Sample Type:	**3200-ton**	**Report Date:**	**7/20/2012**
Sample Date:	**5/25 - 6/1/12**	**MTRF ID:**	**1170PO**
Sample ID:	**PO-024-12**		

Chemical Analysis			**ASTM / AASHTO Limits Class F**	**Class C**	**ASTM Test Method**
Silicon Dioxide (SiO2)	58.50	%			
Aluminum Oxide (Al2O3)	17.58	%			
Iron Oxide (Fe2O3)	4.46	%			
Sum of Constituents	80.54	%	70.0% min	50.0% min	D4326
Sulfur Trioxide (SO3)	0.88	%	5.0% max	5.0% max	D4326
Calcium Oxide (CaO)	9.61	%			D4326
Moisture	0.42	%	3.0% max	3.0% max	C311
Loss on Ignition	0.83	%	6.0% max	6.0% max	C311
			5.0% max	5.0% max	AASHTO M295
Available Alkalies, as Na2O	1.24	%	not required		C311
When required by purchaser			1.5% max	1.5% max	AASHTO M295
Physical Analysis					
Fineness, % retained on #325	19.15	%	34% max	34% max	C311, C430
Fineness Uniformity	0.92	%	5% max	5% max	
Strength Activity Index - 7 or 28 day requirement					C311, C109
7 day, % of control	83	%	75% min	75% min	
28 day, % of control	88	%	75% min	75% min	
Water Requirement, % control	97	%	105% max	105% max	
Autoclave Soundness	0.03	%	0.8% max	0.8% max	C311, C151
Density	2.41				C604
Density Uniformity	1.95	%	5% max	5% max	

Headwaters Resources certifies that pursuant to current ASTM C618 protocol for testing, the test data listed herein was generated by applicable ASTM methods and meets the requirements of ASTM C618 for Class F fly ash.

Bobby Bergman
MTRF Manager

AASHTO R18

Materials Testing & Research Facility
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Taylorsville, Georgia 30178
P: 770.684.0102
F: 770.684.5114

Grace Construction Products

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www.graceconstruction.com

Todd Dragna
Robertson's Ready Mix
200 S. Main st
Corona , California 92366

Project Name: Various Locations
Product Selected: ADVA® 190

This is to certify that the ADVA 190, a High Range Water Reducer, as manufactured and supplied by Grace Construction Products, W.R. Grace & Co. − Conn., is formulated to comply with the Specifications for Chemical Admixtures for Concrete, ASTM: C494, Type A, F, AASHTO: M194, Type A, F and complies with the Specification for Chemical Admixtures for Use in Producing Flowing Concrete, ASTM C 1017.

ADVA 190 does not contain calcium chloride or chloride containing compounds as a functional ingredient. Chloride ions may be present in trace amounts contributed from the process water used in manufacturing.

The foregoing is in addition to and not in substitution for our standard Conditions of Sale attached.

Michael Gardner

Mike Gardner
Western Region Technical Services Manager

Grace Concrete Products

ADVA® 190

High-range water-reducing admixture

ASTM C494 Type A and F, and ASTM C1017 Type I

Product Description

ADVA® 190 is a polycarboxlate-based high-range water-reducing admixture specifically formulated to meet the needs of the concrete industry. It is a low viscosity liquid, which has been formulated by the manufacturer for use as received. ADVA 190 is manufactured under closely controlled conditions to provide uniform, predictable performance and is formulated to comply with specifications for Chemical Admixtures for Concrete, ASTM Designation C494 as a Type A and F, and ASTM C1017 Type I admixture. ADVA 190 does not contain intentionally added calcium chloride. One gallon weighs approximately 8.8 lbs (1.1 kg/L).

Uses

ADVA 190 superplasticizer produces concrete with extremely workable characteristics referred to as high slump. It also allows concrete to be produced with very low water/cement ratios for high strength.

While ADVA 190 is ideal for use in any concrete where it is desired to minimize the water/cementitious ratio yet maintain workability, ADVA 190 is primarily intended for use in ready-mix concrete, but may also be used in other applications such as precast concrete and self-consolidating concrete.

Addition Rates

ADVA 190 superplasticizer addition rates can vary with type of application, but will normally range from 3 to 15 fl oz/100 lbs (195 to 980 mL/100 kg) of cementitious. In most instances, the addition of 3 to 6 fl oz/100 lbs (195 to 375 mL/100 kg) of cementitious will be sufficient. At a given water/cementitious ratio, the slump required for placement can be controlled by varying the addition rate. Should conditions require using more than the recommended addition rates, please consult your Grace representative.

ADVA 190 dosage requirements may also be affected by mix design, cementitious content and aggregate gradations. Please consult with your Grace Construction Products representative for more information and assistance.

Product Advantages

- Highly efficient, producing high slump concrete at very low dosages
- Provides a combination of slump life with near neutral set time
- Consistent air entrainment
- Consistent performance across cement chemistries
- Concrete finishes easily without stickiness, spotty set or tearing

Compatibility with Other Admixtures and Batch Sequencing

ADVA 190 is compatible with most Grace admixtures as long as they are added separately to the concrete mix. However, ADVA products are not recommended for use in concrete containing naphthalene-based admixtures including Daracem® 19 and Daracem 100, and melamine-based admixtures including Daracem ML 330 and Daracem 65. In general, it is recommended that ADVA 190 be added to the concrete mix near the end of the batch sequence for optimum performance. Different sequencing may be used if local testing shows better performance. Please see Grace Technical Bulletin TB-0110, *Admixture Dispenser Discharge Line Location and Sequencing for Concrete Batching Operations* for further recommendations. ADVA 190 should not come in contact with any other admixture before or during batching, even if diluted in mix water.

Pretesting of the concrete mix should be performed before use and as conditions and materials change in order to assure compatibility with other admixtures, and to optimize dosage rates, addition times in the batch sequencing and concrete performance. For concrete that requires air entrainment, the use of an ASTM C260 air-entraining agent (such as Daravair® or Darex® product lines) is recommended to provide suitable air void parameters for freeze-thaw resistance. Please consult your Grace representative for guidance.

Packaging & Handling

ADVA 190 is available in bulk, delivered by metered tank trucks, in 330 gal (1250 L) disposable totes, and in 55 gal (210 L) drums.

It will begin to freeze at approximately 32°F (0°C), but will return to full strength after thawing and thorough agitation. In storage, and for proper dispensing, ADVA 190 should be maintained at temperatures above 32°F (0°C).

Dispensing Equipment

A complete line of accurate, automatic dispensing equipment is available.

ADVA 190 ASTM C494 Type F High-Range Water Reducer Test Data

	US Units		Metric	
	Control	ADVA 190	Control	ADVA 190
Cement (pcy) (kg/m³)	517	517	307	307
Coarse aggregate (pcy) (kg/m³)	1944	1944	1153	1153
Fine aggregate (pcy) (kg/m³)	1144	1214	679	720
Water (pcy) (kg/m³)	235	204	396	344
w/cm	0.455	0.405	0.455	0.405
Slump (inches) (mm)	3.75	3.5	95	90
Plastic air (%)	5.5	5.4	5.5	5.4
Compressive strength				
1 day (psi) (MPa)	1860	2670	12.8	18.4
7 day (psi) (MPa)	4520	5530	31.2	38.1
28 day (psi) (MPa)	5440	6690	37.5	46.1
Initial set time (hr:min)	4:02	3:55	4:02	3:55
Length change 28 day (%)	-0.031	-0.028	-0.031	-0.028
Freeze-thaw resistance (RDME %)	92	98	92	98

www.graceconstruction.com

North American Customer Service: 1-877-4AD-MIX1 (1-877-423-6491)

DC-60A Printed in U.S.A. 11/07 FA/LI/2M

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Robertson's
200 S. Main st
Corona, California 92336

Project Name: Various Locations
Product Selected: WRDA® 64

This is to certify that the WRDA® 64, a(n) Water Reducer, as manufactured and supplied by Grace Construction Products, W.R. Grace & Co. − Conn., is formulated to comply with the Specifications for Chemical Admixtures for Concrete, ASTM: C494, Type A, D AASHTO: M194, Type A, D.

WRDA® 64 does not contain calcium chloride or chloride containing compounds as a functional ingredient. Chloride ions may be present in trace amounts contributed from the process water used in manufacturing.

The foregoing is in addition to and not in substitution for our standard Conditions of Sale attached.

Michael Gardner

Mike Gardner
Western Region Technical Services Manager

Grace Concrete Products

WRDA® 64
Water-reducing admixture
ASTM C494 Type A and D

Product Description

WRDA® 64 is a polymer based aqueous solution of complex organic compounds. WRDA 64 is a ready-to-use low viscosity liquid which is factory pre-mixed in exact proportions to minimize handling, eliminate mistakes and guesswork. WRDA 64 does not contain calcium chloride and weighs approximately 10.1 lbs/gal (1.21 kg/L).

Uses

WRDA 64 produces a concrete with lower water content (typically 8 to 10% reduction), greater plasticity and higher strength. It is used in ready-mix plants, block and concrete product plants, in lightweight and prestressed work wherever concrete is produced.

WRDA 64 also performs especially well in concrete containing fly ash and other pozzolans.

Finishability

The cement paste, or mortar, in WRDA 64 admixtured concrete has improved trowelability. The influence of WRDA 64 on the finishability of lean mixes has been particularly noticeable. Floating and troweling, by machine or hand, imparts a smooth, close tolerance surface.

Addition Rates

The addition rate of WRDA 64 is 3 to 6 fl oz/100 lbs (195 to 390 mL/100 kg) of cement. Pretesting is required to determine the appropriate addition rate for Type A and Type D performance. Optimum addition depends on the other concrete mixture components, job conditions, and desired performance characteristics.

Compatibility with Other Admixtures and Batch Sequencing

WRDA 64 is compatible with most Grace admixtures as long as they are added separately to the concrete mix, usually through the water holding tank discharge line. In general, it is recommended that WRDA 64 be added to the concrete mix near the end of the batch sequence for optimum performance. Different sequencing may be used if local testing shows

Product Advantages

- Consistent water reduction and set times
- Improves performance concrete containing supplementary cementitious materials
- Produces concrete that is more workable, easy to place and finish
- High compressive and flexural strengths

better performance. Please see Grace Technical Bulletin TB-0110, *Admixture Dispenser Discharge Line Location and Sequencing for Concrete Batching Operations* for further recommendations. WRDA 64 should not come in contact with any other admixture before or during the batching process, even if diluted in mix water.

Pretesting of the concrete mix should be performed before use, and as conditions and materials change in order to assure compatibility, and to optimize dosage rates, addition times in the batch sequencing and concrete performance. For concrete that requires air entrainment, the use of an ASTM C260 air-entraining agent (such as Daravair® or Darex® product lines) is recommended to provide suitable air void parameters for freeze-thaw resistance. Please consult your Grace representative for guidance.

Packaging & Handling

WRDA 64 is available in bulk, delivered by metered tank trucks, and in 55 gal (210 L) drums. It will freeze at about 28°F (-2°C), but will return to full strength after thawing and thorough agitation.

Dispensing Equipment

A complete line of accurate, automatic dispensing equipment is available. WRDA 64 may be introduced to the mix on the sand or in the water.

Specifications

Concrete shall be designed in accordance with *Standard Recommended Practice for Selecting Proportions for Concrete*, ACI 211.

The water-reducing (or water-reducing and retarding) admixture shall be WRDA 64, as manufactured by Grace Construction Products, or equal. The admixture shall not contain calcium chloride. It shall be used in strict accordance with the manufacturers' recommendations. The admixture shall comply with ASTM Designation C494, Type A water-reducing (or Type D water-reducing and retarding) admixtures. Certification of compliance shall be made available on request.

The admixture shall be considered part of the total water. The admixture shall be delivered as a ready-to-use liquid product and shall require no mixing at the batching plant or job site.

www.graceconstruction.com

North American Customer Service: 1-877-4AD-MIX1 (1-877-423-6491)

CMD-366G Printed in U.S.A. 5/09 FA/LVI/1M

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3/3/2008

Todd Dragna
Robertson's Ready Mix
200 S. Main St.
Corona , California 92882

Project Name: Various Locations
Product Selected: Recover®

This is to certify that the Recover®, a(n) Hydration Stabilizer, as manufactured and supplied by Grace Construction Products, W.R. Grace & Co. − Conn., is formulated to comply with the Specifications for Chemical Admixtures for Concrete, ASTM: C494, Type D AASHTO: M194, Type D.

Recover® does not contain calcium chloride or chloride containing compounds as a functional ingredient. Chloride ions may be present in trace amounts contributed from the process water used in manufacturing.

The foregoing is in addition to and not in substitution for our standard Conditions of Sale attached.

Michael Gardner

Mike Gardner
Western Region Technical Services Manager

PRODUCT INFORMATION

Recover®

Hydration Stabilizer ASTM C 494, Type D

Description

Recover® is a ready-to-use aqueous solution of chemical compounds specifically designed to stabilize the hydration of portland cement concretes. The ingredients are factory pre-mixed in exact proportions under strict quality control to provide uniform results. One Liter weighs approximately 1.15 kg (one gal weighs approximately 9.6 lbs).

Recover is approved by ASTM C 494 as a Type D retarder.

Uses

Recover is used to stabilize mixer wash water and returned or leftover concrete for extended periods, allowing for reuse of the materials when required. It is also used where controlled set of concrete is needed.

Wash Water

For wash water applications, Recover is used to eliminate the need to discharge wash water from the mixer. This allows the wash water to be used as mix water in the next batch of concrete produced, and prevents the residual plastic concrete from hardening. Stabilization of up to 96 hours is possible depending on dosage rate.

Returned Concrete

For returned or leftover concrete, Recover is used to prevent plastic concrete from reaching initial set. This allows the concrete to be stored in a plastic state and then reused when required. Reuse may require the addition of freshly batched concrete and/or an accelerator such as Daraccel® or PolarSet®. Stabilization of concrete for up to 96 hours is possible depending on dosage rate. Use prevents the waste of unused concrete.

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Set Time Control

Recover is also used in situations where a controlled set time extension is required. Examples include: extended hauls, large continuous pours or pre-batching of concrete for later use.

How Recover Works

Recover stabilizes the hydration process of portland cement preventing it from reaching initial set. This stabilization is not permanent and is controlled by dosage rate. For wash water, the Recover treated water is mixed or sprayed in a specific manner to thoroughly coat the interior of the mixer. The water is used as mix water in the next batch of concrete produced, which then scours the unhardened material from the interior of the mixer. Stabilization of returned or leftover concrete with Recover maintains the plasticity of the concrete for the desired storage duration. This stabilized concrete then resumes normal hydration when the Recover dosage effects subside, or when it is activated by the addition of fresh concrete and/or an accelerator. The result is concrete with normal plastic and hardened properties.

Compatibility

Recover is compatible in wash water and concrete with all ASTM C 494 approved admixtures and ASTM C 260 approved air entraining admixtures. It is necessary to make a preliminary evaluation of the desired properties and to make product adjustments accordingly.

Addition Rates

Addition rates of Recover for wash water range from 180 to 3800 mL (6 to 128 fl oz) per treatment. The amount used will depend on the specific materials involved, mixer type, and stabilization period. Addition rates for returned or leftover concrete will range from 195 to 8350 mL/ 100 kg (3 to 128 fl oz/100 lbs) of cement. The amount used will depend on the specific materials involved, concrete age, temperature conditions, and stabilization period. For set time extension, applications, dosages range from 130 to 3260 mL/100 kg (2 to 50 oz/100 lbs) of cement. Proper dosage rate selection can only be achieved through pretesting. Consult your local Grace admixture representative.

Dispensing Equipment

A complete line of Grace dispensing equipment is available for Recover. This includes the Reach 360™ System which uses an innovative spray wand technology to simplify wash water procedures.

Packaging

Recover is available in bulk, delivered by metered tank trucks and 210 L (55 gal) drums. Recover will freeze, but will return to full effectiveness after thawing and thorough mechanical agitation.

U.S. Patent Nos. 4964917; 5203919; 5427617 and corresponding patents outside of the United States.

Visit our web site at: www.graceconstruction.com   printed on recycled paper

W. R. Grace & Co.-Conn.   62 Whittemore Avenue   Cambridge, MA 02140

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Construction Products

MATERIAL TEST REPORT
ON
CONCRETE AGGREGATES
CONFORMANCE
WITH THE REQUIREMENTS OF
ASTM C 33-08
FOR
ROBERTSON'S
REDLANDS PLANT
REDLANDS, CALIFORNIA

TESTED BY
C. H. J., INCORPORATED
COLTON, CALIFORNIA
JOB NO. 10719-7

Client: Robertson's
Plant: Redlands Plant

Page No. 2
Job No. 10719-7

1. OBJECT

To ascertain the conformance of Robertson's Redlands Plant, Concrete Aggregates with the requirements of ASTM C 33-08 "Standard Specification for Concrete Aggregates".

2 SCOPE

The properties of the concrete aggregates including grading and quality of fine and coarse aggregate are compared to specified requirements to determine the compliance of the aggregates.

3. LABORATORY

The tests were performed by C.H.J., Incorporated, Colton, California. The laboratory is qualified to test concrete aggregates and is in compliance with ASTM E 329 "Standard Specification for Agencies Engaged in Construction Inspection and/or Testing" and was examined by the Cement and Concrete Reference Laboratory of the National Institute of Standards and Technology in January 2011 and accredited by the AASHTO Materials Reference Laboratory on April 9, 2010.

4. REFERENCE DOCUMENTS

ASTM STANDARD (Current 2010 Edition)

C 33	Standard Specifications for Concrete Aggregates
C 40	Standard Test Method for Organic Impurities in Fine Aggregates for Concrete
C 88	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
C 117	Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
C 123	Standard Test Method for Lightweight Particles in Aggregate
C 127	Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
C 128	Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
C 131	Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
C 136	Standard Test Method for Sieve Analysis of Fine and Coarse Concrete Aggregates
C 142	Standard Test Method for Clay Lumps and Friable Particles in Aggregates
C 289	Standard Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method)
D 75	Practice for Sampling Aggregates

5. LABORATORY EQUIPMENT

a. Sample Splitter - Manufactured by Soiltest
b. Aggregate Sample Splitter - Manufactured by Gilson Company
c. Fine Aggregate Shaker - Manufactured by Gilson Company
d. Coarse Aggregate Shaker - Manufactured by Gilson Company
e. Fine Aggregate Sieves - U.S. Standard Sieves Manufactured by Gilson Company
f. Coarse Aggregate Sieves - U.S. Standard Screens Manufactured by Gilson Company
g. Los Angeles Abrasion Machine - Manufactured by Soiltest
h. Drying Oven - Industrial Oven Model 333 Manufactured by Grieve Oven Corporation
i. Scale - 120 pounds, Model No. HV-60KA2 - Manufactured by AND Corporation
j. Scale - 30 pounds, Model No. HW-15KA2 - Manufactured by AND Corporation
k. Scale - 25 pounds, Model No. GP-12K - Manufactured by AND Corporation
l. Digital Scales - 6100 gram capacity - Manufactured by AND Corporation

6. SAMPLING

The concrete aggregates were sampled by a representative of this firm at the Robertson's Redlands Plant on December 10, 2010.

Client: Robertson's
Plant: Redlands Plant

Page No. 4
Job No. 10719-7

7 TEST RESULTS FOR FINE AGGREGATE
Washed Concrete Sand

a. Grading - Sieve Analysis (Standard U.S. Sieves) - (ASTM C 136)

Sieve Size	Percent Passing
3/8" (9.5 mm)	100
No. 4 (4.75 mm)	96
No. 8 (2.36 mm)	76
No. 16 (1.18 mm)	57
No. 30 (600 μm)	40
No. 50 (300 μm)	24
No. 100 (150 μm)	13
Fineness Modulus	2.94

b. Deleterious Substances

Material Finer Than No. 200 Sieve (75 μm sieve) (ASTM C 117)	4.8 percent
Organic Impurities (ASTM C 40)	Lighter than Standard (Satisfactory)
Clay Lumps and Friable Particles (ASTM C 142)	0.2 percent
Coal and Lignite (ASTM C 123)	0.0 percent

c. Soundness (ASTM C 88)

Sodium Sulfate Soundness (Loss After 5 Cycles)	1.74 percent

d. Potential Reactivity (ASTM C 289)

Chemical Method: Considered Innocuous — Rc = 80 mm/L, Sc = 16.7 mm/L

Client: Robertson's
Plant: Redlands Plant

Page No. 5
Job No. 10719-7

8. TEST RESULTS FOR COARSE AGGREGATES
3/8-Inch Maximum Aggregate (9.5 mm) SSPWC Size No. 4

a. Grading - Sieve Analysis (Standard U.S. Sieves) - (ASTM C 136)

Sieve Size	Percent Passing
1/2" (12.5 mm)	100
3/8" (9.5 mm)	97
No. 4 (4.75 mm)	20
No. 8 (2.36 mm)	7
No. 16 (1.18 mm)	4

b. Deleterious Substances

Material Finer Than No. 200 Sieve (75 µm sieve) (ASTM C 117)	0.8 percent
Clay Lumps and Friable Particles (ASTM C 142)	0.5 percent
Coal and Lignite (ASTM C 123)	0.0 percent
Abrasion (C Grading): (ASTM C 131)	
Loss After 100 Revolutions	14.0 percent
Loss After 500 Revolutions	50.0 percent

c. Soundness (ASTM C 88)
(Combined Coarse Sample)

Sodium Sulfate Soundness (Loss After 5 cycles) 1.08 percent

d. Potential Reactivity (ASTM C 289)
Composite Coarse Sample

Chemical Method: Considered Innocuous
Rc = 90 mm/L
Sc = 23.0 mm/L

Client: Robertson's
Plant: Redlands Plant

Page No. 6
Job No. 10719-7

9. TEST RESULTS FOR COARSE AGGREGATES
1-Inch Maximum Aggregate (25 mm) SSPWC Size No. 3

a. Grading - Sieve Analysis (Standard U.S. Sieves) - (ASTM C 136)

Sieve Size	Percent Passing
1 1/2" (37.5 mm)	100
1" (25 mm)	99
3/4" (19 mm)	85
1/2" (12.5 mm)	34
3/8" (9.5 mm)	10
No. 4 (4.75 mm)	3

b. Deleterious Substances

Material Finer Than No. 200 Sieve (75 µm sieve) (ASTM C 117)	0.8 percent
Clay Lumps and Friable Particles (ASTM C 142)	0.1 percent
Coal and Lignite (ASTM C 123)	0.0 percent
Abrasion (B Grading): (ASTM C 131)	
Loss After 100 Revolutions	14.0 percent
Loss After 500 Revolutions	47.0 percent

c. Soundness (ASTM C 88)
(Combined Coarse Sample)

Sodium Sulfate Soundness (Loss After 5 cycles) — 1.08 percent

d. Potential Reactivity (ASTM C 289)
Composite Coarse Sample

Chemical Method: Considered Innocuous — Rc = 90 mm/L; Sc = 23.0 mm/L

Client: Robertson's
Plant: Redlands Plant

Page No. 7
Job No. 10719-7

10. TEST RESULTS FOR COARSE AGGREGATES
1 1/2-Inch Maximum Aggregate (37.5 mm) SSPWC Size No. 2

a. Grading - Sieve Analysis (Standard U.S. Sieves) - (ASTM C 136)

Sieve Size	Percent Passing
2" (50 mm)	100
1 1/2" (37.5 mm)	95
1" (25 mm)	24
3/4" (19 mm)	5
1/2" (12.5 mm)	2
3/8" (9.5 mm)	2

b. Deleterious Substances

Material Finer Than No. 200 Sieve (75 µm sieve) (ASTM C 117)	0.6 percent
Clay Lumps and Friable Particles (ASTM C 142)	0.1 percent
Coal and Lignite (ASTM C 123)	0.0 percent
Abrasion (A Grading): (ASTM C 131)	
Loss After 100 Revolutions	15.0 percent
Loss After 500 Revolutions	49.0 percent

c. Soundness (ASTM C 88)
(Combined Coarse Sample)

Sodium Sulfate Soundness (Loss After 5 cycles) — 1.08 percent

d. Potential Reactivity (ASTM C 289)
Composite Coarse Sample

Chemical Method: Considered Innocuous

Rc = 90 mm/L
Sc = 23.0 mm/L

Client: Robertson's
Plant: Redlands Plant

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11. EVALUATION OF TEST RESULTS

a. Fine Aggregate - Washed Concrete Sand

Grading - Sieve Analysis

U.S. Standard Sieves	ASTM C 33-08 (1) Requirements	SSPWC 2009 Requirements	Test Results
	Percent Passing		
3/8" (9.5 mm)	100	100	100
No. 4 (4.75 mm)	95-100	95-100	96
No. 8 (2.36 mm)	80-100	75-90	76
No. 16 (1.18 mm)	50-85	55-75	57
No. 30 (600 µm)	25-60	30-50	40
No. 50 (300 µm)	5-30	10-25	24
No. 100 (150 µm)	0-10	2-10	13
Fineness Modulus	2.3-3.1		2.94

(1) Concrete aggregates produced in Southern California are generally produced to meet the grading requirements of the Standard Specifications for Public Works Construction or other local or state requirements.

Deleterious Substances	ASTM C 33-08 Requirements	Test Results
Material Finer Than No. 200 Sieve (75 µm sieve)	5.0 percent maximum*	4.8 Percent
Organic Impurities	Must be lighter than standard	Lighter than Standard
Clay Lumps and Friable Particles	3.0 percent maximum	0.2 percent
Coal and Lignite	1.0 percent maximum**	0.0 percent

* Concrete subject to abrasion shall have a maximum of 3.0 percent materials finer than the No. 200 sieve (75 µm sieve).

** Concrete where surface appearance is important shall have a maximum of 0.5 percent

Client: Robertson's
Plant: Redlands Plant

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a. Fine Aggregate - Washed Concrete Sand Cont'd

Parameter	ASTM C 33-08 Requirements	Test Results
Soundness Sodium Sulfate (Loss After 5 Cycles)	10 percent maximum	1.74 percent
Potential Reactivity (ASTM C 289) Chemical Method	Must not be considered as potentially reactive	Considered Innocuous Rc = 80 mm/L Sc = 16.7 mm/L

b. Coarse Aggregate - 3/8-Inch Maximum Aggregate (9.5 mm) SSPWC Size No. 4

Grading - Sieve Analysis

U.S. Standard Sieves	ASTM C 33-08 (1) Size No. 8 Requirements	SSPWC 2009 Size No. 4 Requirements	Test Results
	Percent Passing		
1/2" (12.5 mm)	100	100	100
3/8" (9.5 mm)	85-100	85-100	97
No. 4 (4.75 mm)	10-30	0-30	20
No. 8 (2.36 mm)	0-10	0-10	7
No. 16 (1.18 mm)	0-5	0-2	4

(1) Concrete aggregates produced in Southern California are generally produced to meet the grading requirements of the Standard Specifications for Public Works Construction or other local or state requirements.

Client: Robertson's
Plant: Redlands Plant

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b. Coarse Aggregate - 3/8-Inch Maximum Aggregate (9.5 mm) SSPWC Size No. 4 Cont'd

Deleterious Substances	ASTM C 33-08 Requirements	Test Results
Material Finer Than No. 200 Sieve (75 µm sieve)	1.0 percent maximum	0.8 percent
Clay Lumps and Friable Particles	2.0 to 10 percent maximum	0.5 percent
Coal and Lignite	1.0 percent maximum*	0.0 percent
Abrasion Loss After 500 Revolutions	50 percent maximum	50.0 percent

* Concrete where surface appearance is important shall have a maximum of 0.5 percent

Parameter	ASTM C 33-08 Requirements	Test Results
Soundness Sodium Sulfate (Loss After 5 Cycles)	12 percent maximum	1.08 percent
Potential Reactivity (ASTM C 289) Chemical Method	Must not be considered as potentially reactive	Considered Innocuous Rc = 90 mm/L Sc = 23.0 mm/L

Client: Robertson's
Plant: Redlands Plant

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c. Coarse Aggregate - 1-Inch Maximum Aggregate (25 mm) SSPWC Size No. 3

Grading - Sieve Analysis

U.S. Standard Sieves	ASTM C 33-08 (1) Size No. 56 Requirements	SSPWC 2009 Size No. 3 Requirements	Test Results
	Percent Passing		
1 1/2" (37.5 mm)	100	100	100
1" (25 mm)	90-100	90-100	99
3/4" (19 mm)	40-85	55-85	85
1/2" (12.5 mm)	10-40		34
3/8" (9.5 mm)	0-15	8-20	10
No. 4 (4.75 mm)	0-10	0-5	3

(1) Concrete aggregates produced in Southern California are generally produced to meet the grading requirements of the Standard Specifications for Public Works Construction or other local or state requirements.

Deleterious Substances	ASTM C 33-08 Requirements	Test Results
Material Finer Than No. 200 Sieve (75 µm sieve)	1.0 percent maximum	0.8 percent
Clay Lumps and Friable Particles	2.0 to 10 percent maximum	0.1 percent
Coal and Lignite	1.0 percent maximum*	0.0 percent
Abrasion Loss After 500 Revolutions	50 percent maximum	47.0 percent

* Concrete where surface appearance is important shall have a maximum of 0.5 percent

Client: Robertson's
Plant: Redlands Plant

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c. Coarse Aggregate - 1-Inch Maximum Aggregate (25 mm) SSPWC Size No. 3 Cont'd

Parameter	ASTM C 33-08 Requirements	Test Results
Soundness Sodium Sulfate (Loss After 5 Cycles)	12 percent maximum	1.08 percent
Potential Reactivity (ASTM C 289) Chemical Method	Must not be considered as potentially reactive	Considered Innocuous Rc = 90 mm/L Sc = 23.0 mm/L

d. Coarse Aggregate - 1 1/2-Inch Maximum Aggregate (37.5 mm) SSPWC Size No. 2

Grading - Sieve Analysis

U.S. Standard Sieves	ASTM C 33-08 (1) Size No. 4 Requirements	SSPWC 2009 Size No. 2 Requirements	Test Results
	Percent Passing		
2" (50 mm)	100	100	100
1 1/2" (37.5 mm)	90-100	90-100	95
1" (25 mm)	20-55	5-40	24
3/4" (19 mm)	0-15	0-15	5
1/2" (12.5 mm)			2
3/8" (9.5 mm)	0-5	0-5	2

(1) Concrete aggregates produced in Southern California are generally produced to meet the grading requirements of the Standard Specifications for Public Works Construction or other local or state requirements.

Client: Robertson's
Plant: Redlands Plant

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d. Coarse Aggregate - 1 1/2-Inch Maximum Aggregate (37.5 mm) SSPWC Size No. 2 Cont'd

Deleterious Substances	ASTM C 33-08 Requirements	Test Results
Material Finer Than No. 200 Sieve (75 µm sieve)	1.0 percent maximum	0.6 percent
Clay Lumps and Friable Particles	2.0 to 10 percent maximum	0.1 percent
Coal and Lignite	1.0 percent maximum*	0.0 percent
Abrasion Loss After 500 Revolutions	50 percent maximum	49.0 percent

* Concrete where surface appearance is important shall have a maximum of 0.5 percent

Parameter	ASTM C 33-08 Requirements	Test Results
Soundness Sodium Sulfate (Loss After 5 Cycles)	12 percent maximum	1.08 percent
Potential Reactivity (ASTM C 289) Chemical Method	Must not be considered as potentially reactive	Considered Innocuous Rc = 90 mm/L Sc = 23.0 mm/L

Client: Robertson's
Plant: Redlands Plant

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CONCLUSIONS

The Washed Concrete Sand, 3/8-Inch (9.5 mm) Maximum (SSPWC No. 4), 1-Inch (25 mm) Maximum (SSPWC No. 3), and 1 1/2-Inch (50 mm) Maximum (SSPWC No. 2) Aggregates from the Robertson's Redlands plant meet the quality requirements of ASTM C 33-08, "Standard Specifications for Concrete Aggregates" and the size grading requirement of ASTM C 33-08 and/or the 2009 Standard Specification for Public Works Construction.

REGISTERED PROFESSIONAL ENGINEER
GEORGE BATTEY III
No. C34323
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Respectfully submitted,
H J, INCORPORATED

George Battey III

Date: February 8, 2011

George Battey III
Registered Civil Engineer No. 34323
Registration Expires 09-30 2011

JMD/GB:ndt

Distribution: Robertson's (4)

REGISTERED PROFESSIONAL ENGINEER
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George Battey

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Appendix I-C

EXTERNAL INSTRUMENTATION DETAILS FOR HD1.3 TESTS 1 THROUGH 4

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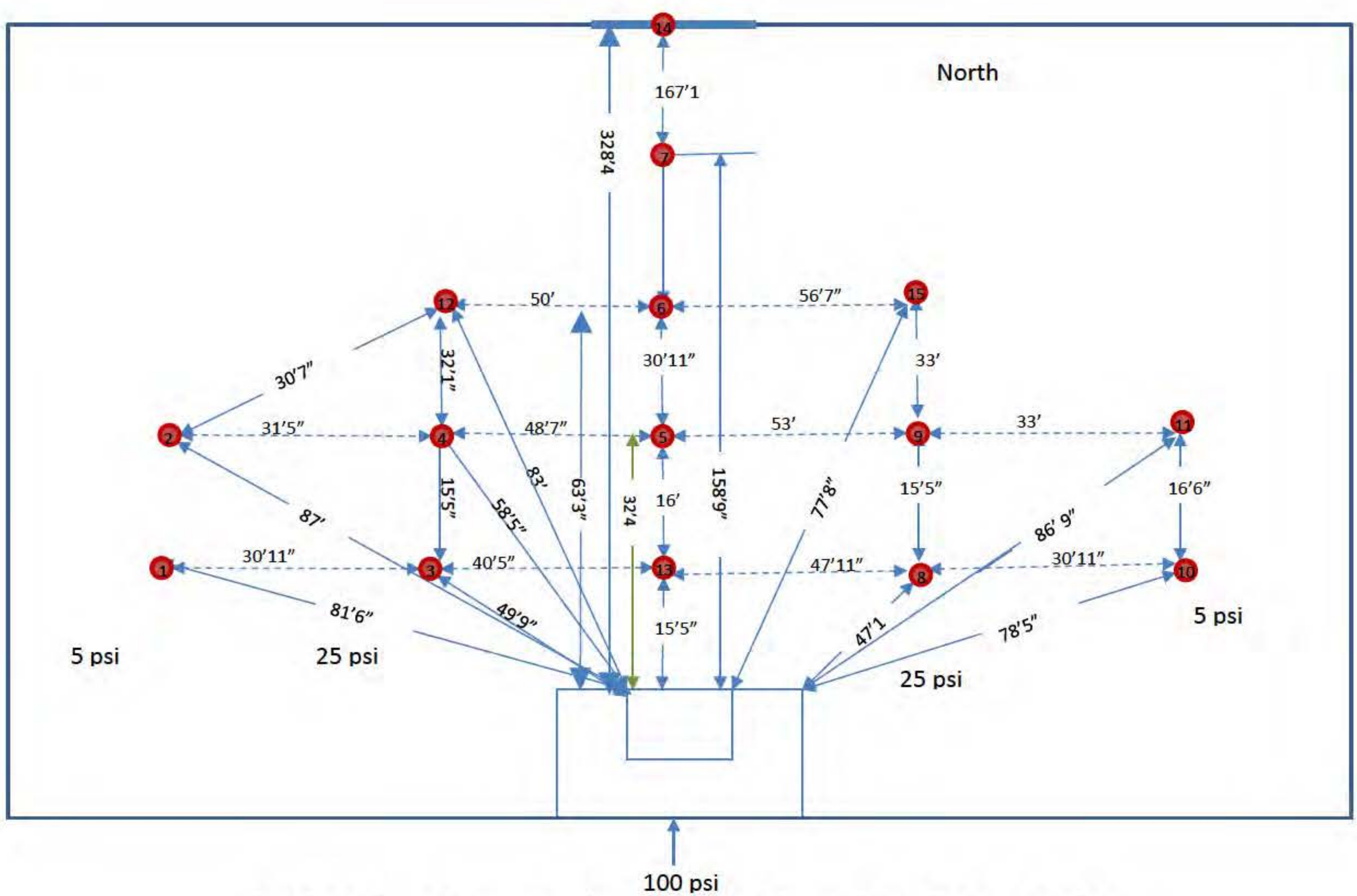

FIGURE I-C-1. Pressure Gage Measurements to Front of Gage for Tests 1 and 2.

Location	Pressure (psi)	Back DFT Plate # (Away from Structure)	Front DFT Plate # (Towards Structure)	Height of Pressure Gage (in)	Height of DFT (in)
1	5	104	103	48.75	31.5
2	5	113	112	48.312	30.75
3	25	109	105	48.75	31.75
4	25	236	235	48.75	31.75
5	100	234	233	48	31.25
6	50	309	310	46.5	31.75
7	20	205	206	46.5	34.25
8	25	237	238	48.75	31.25
9	25	111	110	48.75	31.5
10	5	316	323	48.75	31.75
11	5	207	208	49.125	32
12	NA	203	204	NA	31.75
13	NA	102	101	NA	33
14	NA	305	322	NA	29.75
15	NA	303	304	NA	33

FIGURE I-C-2. DTF and Pressure Gage Details for Tests 1 and 2.

DTF Plate Thickness		
DFT 103 & 104 – 22.07 mm 104 1.63 mm 103 1.97 mm	DFT 101 & 102 – 20.61 mm 101 1.75 mm 102 1.72 mm	DFT 323 & 316 – 21.99 mm 323 1.88 mm 316 1.71 mm
DFT 113 & 112 – 21.47 mm 113 1.62 mm 112 1.61 mm	DFT 234 & 233 – 22.20 mm 234 1.82 mm 233 1.65 mm	DFT 208 & 207 – 22.02 mm 208 1.60 mm 207 1.63 mm
DFT 204 & 203 – 22.16 mm 204 1.68 mm 203 1.63 mm	DFT 310 & 309 – 21.67 mm 310 1.86 mm 309 1.84 mm	DFT 206 & 205 – 22.30 mm 206 1.71 mm 205 1.56 mm
DFT 235 & 236 – 22.62 mm 235 1.75 cm 236 1.75 cm	DFT 304 & 303 – 22.64 mm 304 1.62 mm 303 1.67 mm	DFT 322 & 305 – 22.40 mm 322 1.73 mm 305 1.76 mm
DFT 105 & 109 – 22.55 mm 105 1.76 mm 109 1.69 mm	DFT 238 & 237 – 22.48 mm 238 1.59 mm 237 1.56 mm	West DFT 307 & 325 – mm 307 1.60 mm East 218 1.63 mm

FIGURE I-C-3. DFT Plate Thickness for Tests 1 and 2.

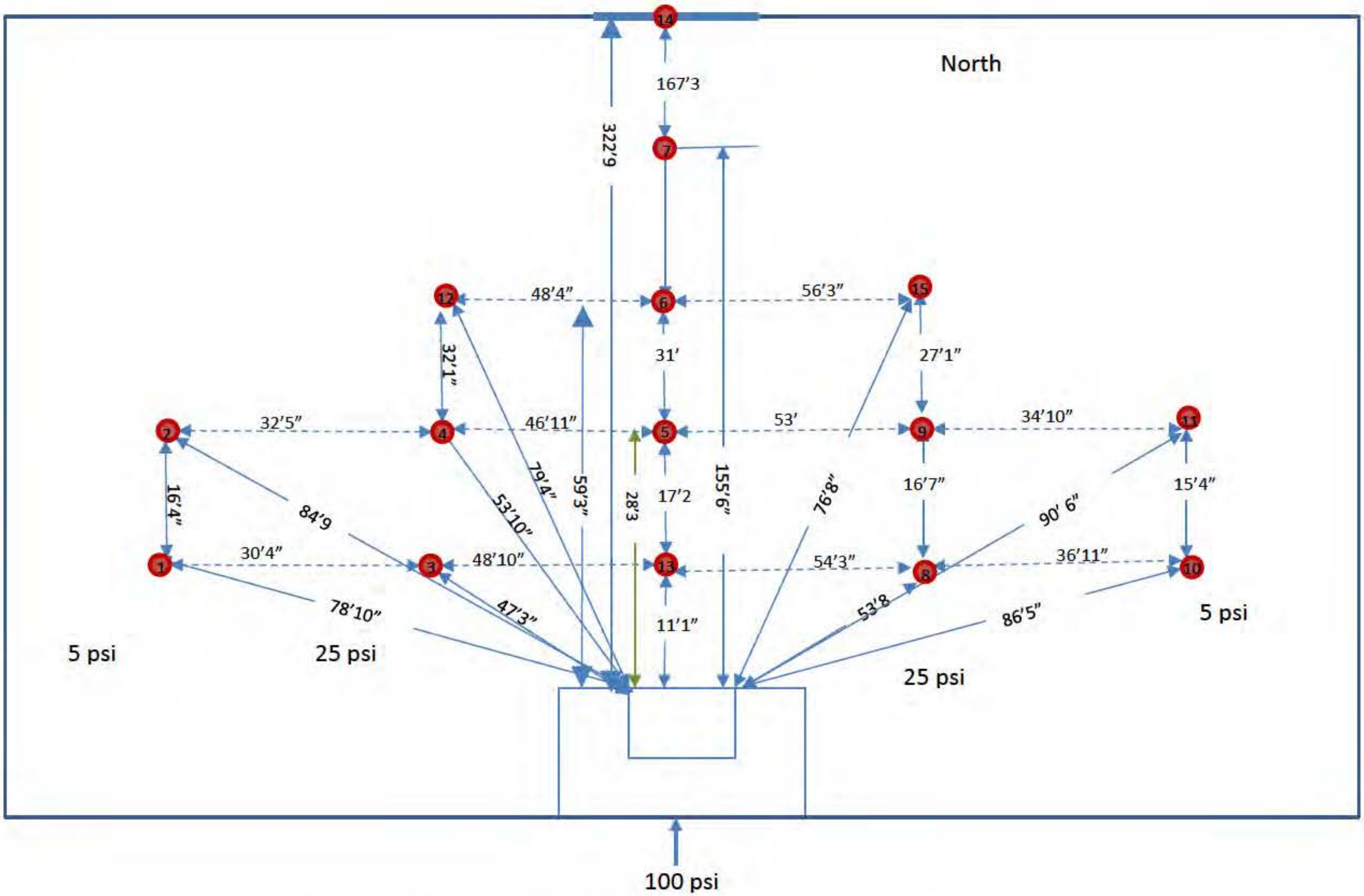

FIGURE I-C-4. Pressure Gage Measurements to Front of Gage for Tests 3 and 4.

Location	Pressure (psi)	Back DFT Plate # (Away from Structure)	Front DFT Plate # (Towards Structure)	Height of Pressure Gage (in)	Height of DFT (in)
1	5	104	103	48.75	31.5
2	5	113	112	48.312	30.75
3	25	109	105	48.75	31.75
4	25	236	235	48.75	31.75
5	100	234	233	48	31.25
6	50	309	310	46.5	31.75
7	20	205	206	46.5	34.25
8	25	237	238	48.75	31.25
9	25	111	110	48.75	31.5
10	5	316	323	48.75	31.75
11	5	207	208	49.125	32
12	NA	203	204	NA	31.75
13	NA	102	101	NA	33
14	NA	305	322	NA	29.75
15	NA	303	304	NA	33

FIGURE I-C-5. DTF and Pressure Gage Details for Tests 3 and 4.

DFT 103 & 104 – 22.07 mm 104 1.63 mm 103 1.97 mm	DFT 101 & 102 – 20.61 mm 101 1.75 mm 102 1.72 mm	DFT 323 & 316 – 21.99 mm 323 1.88 mm 316 1.71 mm
DFT 113 & 112 – 21.47 mm 113 1.62 mm 112 1.61 mm	DFT 234 & 233 – 22.20 mm 234 1.82 mm 233 1.65 mm	DFT 208 & 207 – 22.02 mm 208 1.60 mm 207 1.63 mm
DFT 204 & 203 – 22.16 mm 204 1.68 mm 203 1.63 mm	DFT 310 & 309 – 21.67 mm 310 1.86 mm 309 1.84 mm	DFT 206 & 205 – 22.30 mm 206 1.71 mm 205 1.56 mm
DFT 235 & 236 – 22.62 mm 235 1.75 cm 236 1.75 cm	DFT 304 & 303 – 22.64 mm 304 1.62 mm 303 1.67 mm	DFT 322 & 305 – 22.40 mm 322 1.73 mm 305 1.76 mm
DFT 105 & 109 – 22.55 mm 105 1.76 mm 109 1.69 mm	DFT 238 & 237 – 22.48 mm 238 1.59 mm 237 1.56 mm	West DFT 307 & 325 – mm 307 1.60 mm East 218 1.63 mm

FIGURE I-C-6. DFT Plate Thickness for Tests 3 and 4.

Appendix I-D

M1 HEAT FLUX MEASUREMENTS

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TABLE I-D-1. Heat Flux Measured in Tests With M1-Type Propellant.

Source	Propellant	Mass, kg	Distance, m	Heat Flux, kW/m^2
Hay & Watson (Reference I-12) Open burn	M1 SP	49.9	2.5	84
		49.9	3.2	94
		99.8	2.5	243
	M1 MP	47.6	2.5	75
		47.6	3.2	67
		47.6	2.5	100
		95.3	6.4	60
Hay and Watson also have values for IMR 5010, WC844, WC846, and another WC for .30 cal.				
Allain Test 1 (Reference I-5) Earth-covered metal arch open on end and placed on ground	Similar to M1	2,184 kg of M1 like 2,220 kg total charge	15 m L x, 2 m y	~ 90
			15 m L, 7 m y	~110
			15 m L, 12 m y	~125
			25 m L, 2 m y	~50
			25 m L, 7 m y	~55
			25 m L, 12 m y	~55
			15 m R, 2 m y	~80
			15 m R, 7 m y	~110
			15 m R, 12 m y	~110
			25 m R, 2 m y`	~48
			25 m R, 7 m y	~50
			25 m R, 12 m y	~55
Allain Test 2 Earth-covered metal arch, with metal front wall with square opening, placed on ground	Similar to M1	2,184 kg of M1 like 2,220 kg total charge	15 m L x, 2m y	~50
			15 m L, 7 m y	~79
			15 m L, 12 m y	~115
			25 m L, 2 m y	~30
			25 m L, 7 m y	~40
			25 m L, 12 m y	~45
			15 m R, 2 m y	~58
			15 m R, 7 m y	~122
			15 m R, 12 m y	~130
			25 m R, 2 m y`	~30
			25 m R, 7 m y	~34
			25 m R, 12 m y	~60

TABLE I-D-1. Heat Flux Measured in Tests With M1-Type Propellant (Contd).

Source	Propellant	Mass, kg	Distance, m	Heat Flux, kW/m^2
Allain Test 3 Reinforced earth-covered metal arch, with concrete front wall with square opening, anchored to ground, choked flow, structure ruptures	Similar to M1	2,184 kg of M1 like 2,220 kg total charge	15 m L x, 2 m y 15 m, 12 m y 15 m L, 40 m y 25 m L, 2 m y 25 m L, 12 m y 25 m L, 40 m y 15 m R, 2 m y 15 m R, 12 m y 15 m R, 40 m y 25 m R, 2 m y 25 m R, 12 m y 25 m R, 40 m y	~82 ~70 ~10 ~60 ~43 ~10 ~66 ~82 ~9 ~40 ~41 ~8
Allain Test 4 Earth-covered concrete structure, with box shaped internal metal liner mounted on base, metal partial plate with opening above, and earth fill behind metal plate	Similar to M1	2,037 kg	No flux data, limited by rupture of structure. Structure ruptured 1 second after ignition.	
Joachim Test 1 Unchoked	M1 SP	10 kg		0.084-0.126 in exit pipe
Joachim Test 2 Unchoked		25 kg		0.105 in exit pipe
Joachim Test 3 Unchoked		100 kg		0.419-0.84 in exit pipe
Joachim Test 4 Choked		250 kg		Rupture occurred at 6 secs

Hay and Watson (Reference I-12) conducted tests with M1 single and M1 multiple perforation grains (as well as with IMR 5010, WC844, WC846, and another WC for .30 caliber gun propellants) in open burns and measured the heat flux at 2.5-, 3.2-, and 6.4-m distances from the propellant. They measured the peak flux (reported in Table I-3) and the average peak over a 5-second interval. Allain's data (Reference I-5) were for the fireballs associated with his Tests 1 and 2, and for the plume of Test 3 before the structure ruptured.

Joachim's heat flux data (Reference I-4) are also interesting as it was measured in the pipe exiting the concrete structure. His Tests 1 through 3 were unchoked flow, and he commented that unburned propellant exited via the pipe and burned outside the pipe. This is consistent with the observations of Herrera et al. who also studied the combustion of M1 propellant in a structure, once again with unchoked flow. They observed that unburned propellant exited the structure unburned and burned external to the structure. The lower values of heat flux in the pipe data of Joachim are consistent with there being unburned propellant in the pipe.

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CHAPTER II. TEST 1—SUFFICIENT VENT AREA TO ENSURE UNCHOKED FLOW AND ONLY LOW PRESSURE WITHIN THE STRUCTURE

Test 1 was conducted 16 November 2012 at the Airport Lake dry lake bed test site at the Naval Air Warfare Center Weapons Division (NAWCWD), China Lake, California. This test was the first of four tests and was used to gain a better understanding of the duration of the event, plume/fireball characteristics, and instrumentation. No data were available prior to this test to predict the duration of the event and to identify the most effective instrumentation. This test allowed the research team to identify optimal data collection rates and instrumentation techniques. Test 1 provided the initial data that began the process of refining the HD1.3 hazards description.

TEST CONFIGURATION

M1 gun propellant was the energetic material used in Test 1. The propellant samples were obtained from Hawthorne, Nevada, from the demilitarization account.

The samples used in Test 1 were the small cylinders of propellant having a single perforation in the center (1P). The nominal dimensions were a 1.22-mm outer diameter, a 5.03-mm length, and a 0.514-mm perforation diameter. Photos of this material were presented in Chapter I.

Three drums of propellant were placed on a pallet inside the structure as shown in Figure II-1.

FIGURE II-1. Three Drums of M1 Propellant
Placed Within the Structure for Test 1.

The three drums each had 98.6 pounds of M1 propellant for a total weight of 296 pounds. The propellant bed depth in each of the drums was 14.5 inches from the top of the barrel. The loading density for Test 1 was 16.78 kg of propellant per cubic meter (m^3) of internal volume of structure.

After the drums were placed in the structure, the face plate with the 79-cm-diameter orifice was secured to the structure as described in Chapter I. The large orifice diameter for Test 1 ensured that the flow of the combustion gases out of the orifice during Test 1

would be unchoked flow. The unchoked flow assures that the internal pressure in the structure would be low, on the order of 1 to 2 pounds per square inch (psi).

Surveillance cameras and break wires were used in the structure to determine the mass regression rate of the propellant and to assess how the fire might propagate inside the structure. Two surveillance cameras were placed in the top corners of the west wall positioned so that they would record the ignition and the burning of the propellant. Break wires were placed between the pallet and each barrel. Unfortunately, the cameras were compromised by the heat in the structure, and the break wire data were lost. Test 1 external heat flux data were lost due to failure of a data collection system.

GAGE LOCATIONS

The Test 1 interior gage locations are oriented with the north opening of the structure facing the reader (Figure II-2).

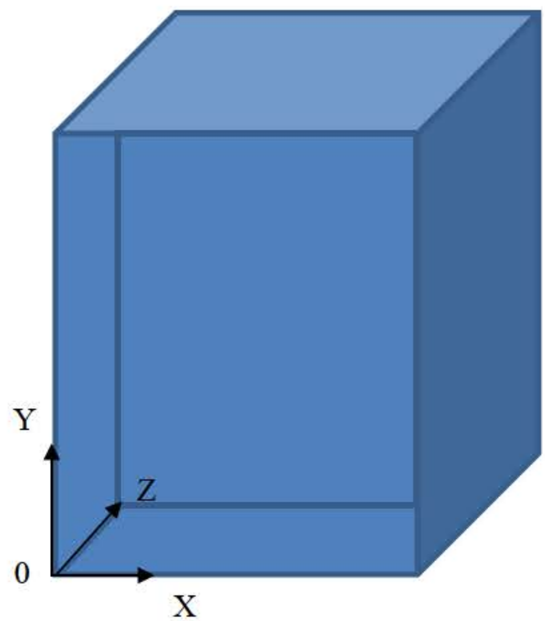

FIGURE II-2. Reference Figure for Internal Instrumentation.

The inside gage locations are presented in Table II-1 for Test 1. Outside gage locations are listed in Table II-2 and illustrated in Chapter I. Appendix I-C provides the measured locations of the gages external to the Test 1 structure. These schematics are provided to assure that any inconsistencies in numbering instrumentation are documented so thermal and pressure signatures can be compared between tests.

TABLE II-1. Gage Description of Inside Structure for Test 1.

Gage	ID	Location, inches			Comments
		X	Y	Z	
Thermocouple	1	78.72	59.22	61.72	West wall, top, south (top far corner*)
Thermocouple	2	78.72	57.72	20.25	West wall, top, north (top near corner*)
Thermocouple	3	78.72	21.00	61.22	West wall, bottom, south (bottom far corner*)
Thermocouple	4	78.72	20.00	16.25	West wall, bottom, north (bottom near corner*)
Thermocouple	5	76.72	69.97	1.125	South wall, top, west (upper right corner*)
Thermocouple	6	76.72	8.75	76.595	South wall, bottom, west (lower right corner*)
Thermocouple	7	2.5	70.22	76.22	South wall, top east (upper left corner*)
Thermocouple	8	2.25	8.5	76.72	South wall, bottom, east (lower left corner*)
Thermocouple	9	0	41.125	41.5	East wall, centered
Thermocouple	10	2.25	70.22	3	North wall, top, east (upper left corner*)
Thermocouple	11	1.75	8.75	1.75	North wall, bottom, east (lower-left corner*)
Thermocouple	12	40.47	76.47	8.5	North wall, top, center (above door*)
Thermocouple	13	39.22	8.75	3	North wall, bottom, center (below door*)
Thermocouple	14	76.22	69.97	2	North wall, top, west (upper right corner*)
Thermocouple	15	75.97	8.75	2	North wall, bottom, west (lower right corner*)
Thermocouple	16	35.5	78.72	39.22	Centered on ceiling
Thermocouple	17	39	2	39.22	Centered on floor
Thermocouple	18				On barrel
Thermocouple	19				On barrel
Thermocouple	20				On barrel
DFT	16	0	47.5	34.5	East wall centered
DFT	17	78.72	47.5	34.5	West wall centered
Pressure	PI-1	78.72	61.00	29.72	West wall centered
Pressure	PI-2	78.72	59.25	37.22	West wall – stunt
Pressure	PI-3	39.00	36.72	78.72	South wall centered
Pressure	PI-4	0	41.125	40.5	East wall centered
Pressure	PI-5	35.5	78.72	39.22	Ceiling centered
Pressure	PI-6	39.00	0	37.47	Floor

*looking into structure from north facing door.

TABLE II-2. Gage Description Outside Structure.

Gage	ID	Location
DFT	DFT1	82 feet west of center line, 15 feet from north wall
	DFT2	82 feet west of center line, 30 feet from north wall
	DFT3	50 feet west of center line, 15.75 feet from north wall
	DFT4	50 feet west of center line, 28.58 feet from north wall
	DFT5	Center line, 32.33 feet from north wall
	DFT6	Center line, 63.75 feet from north wall
	DFT7	Center line, 158.75 feet from north wall
	DFT8	50 feet east of center line, 15 feet from north wall
	DFT9	50 feet east of center line, 30 feet from north wall
	DFT10	82 feet east of center line, 15 feet from north wall
	DFT11	82 feet east of center line, 30 feet from north wall
	DFT12	50 feet west of center line, 63.75 feet from north wall
	DFT13	Center line, 15 feet from north wall
	DFT14	Center line, 325.83 feet from north wall
	DFT15	50 feet from center line, 63.75 feet from north wall
Pressure	PO1	82 feet west of center line, 15 feet from north wall
Pressure	PO2	82 feet west of center line, 30 feet from north wall
Pressure	PO3	50 feet west of center line, 15.75 feet from north wall
Pressure	PO4	50 feet west of center line, 28.58 feet from north wall
Pressure	PO5	Center line, 32.33 feet from north wall
Pressure	PO6	Center line, 63.75 feet from north wall
Pressure	PO7	Center line, 158.75 feet from north wall
Pressure	PO8	50 feet east of center line, 15 feet from north wall
Pressure	PO9	50 feet east of center line, 30 feet from north wall
Pressure	PO10	82 feet east of center line, 15 feet from north wall
Pressure	PO11	82 feet east of center line, 30 feet from north wall

TEST 1 RESULTS

INSIDE STRUCTURE

A plot of the inside pressure versus time is given in Figure II-3. Note should be taken that the time stamp on these graphs reflects the time the data acquisition systems were triggered. The trigger was performed manually for Test 1. Additional plots of pressure, temperature, flux, and Doppler data can be found in Appendixes II-A, II-B, and II-D.

The pressure rise inside the structure during Test 1 was minimal with the maximum pressure being on the order of 2 psi, due to unchoked flow, as anticipated. The temperature inside the structure varied by location with the maximum measured being approximately 800°C on TC 7, north wall, lower center (Figure II-4).

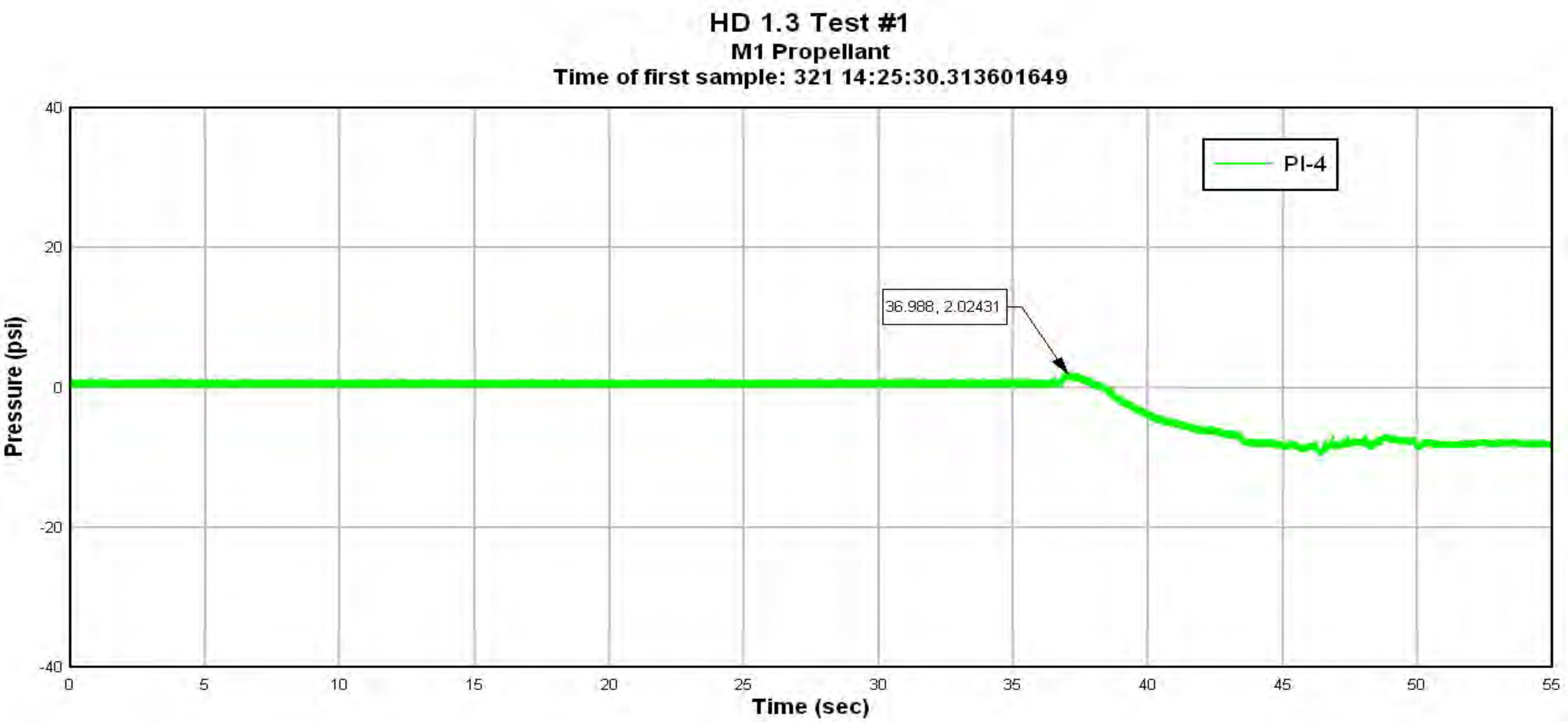

FIGURE II-3. Pressure Versus Time Inside Structure of Test 1.

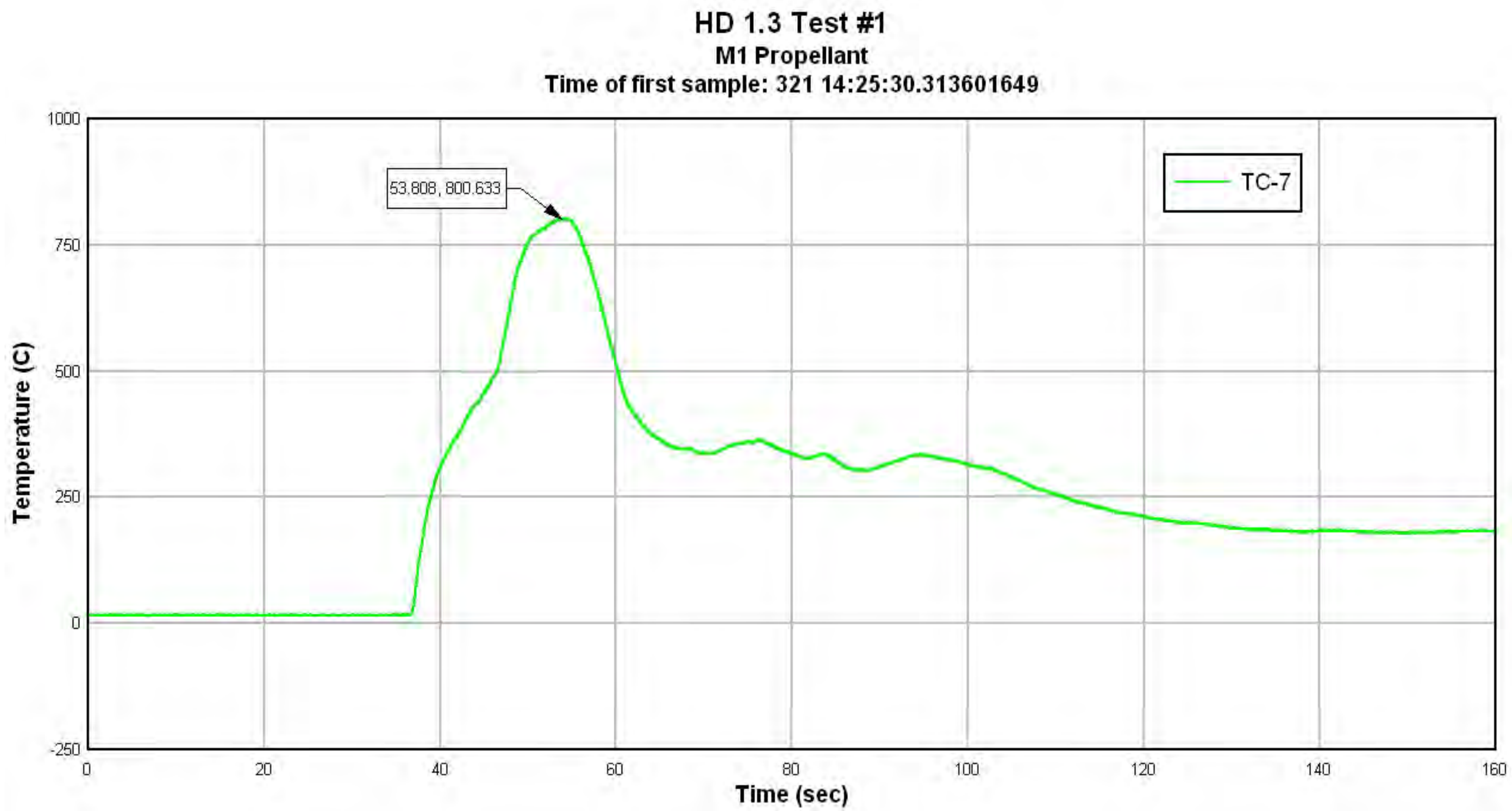

FIGURE II-4. Temperature Versus Time Inside Structure of Test 1.

Figure II-5 presents the heat flux within the structure for Test 1. The maximum flux in the structure was 1,835.44 kW/m^2, but only lasted a short time during the ignition phase of the propellant. The maximum flux then decreased to between 150 and 500 kW/m^2. The DFT temperatures and duration were used to determine the heat flux. A maximum temperature of approximately 753°C was observed within the structure. The thermal trace shows a rapid temperature increase from ambient temperature (35°C) to above 200°C within 37 seconds of recorded instrumentation. The temperature remained above 200°C for over 240 seconds. Figure II-6 provides the thermal profiles as determined from heat flux gage 16 internal to the structure. Additional thermal plots can be found in Appendix II-B.

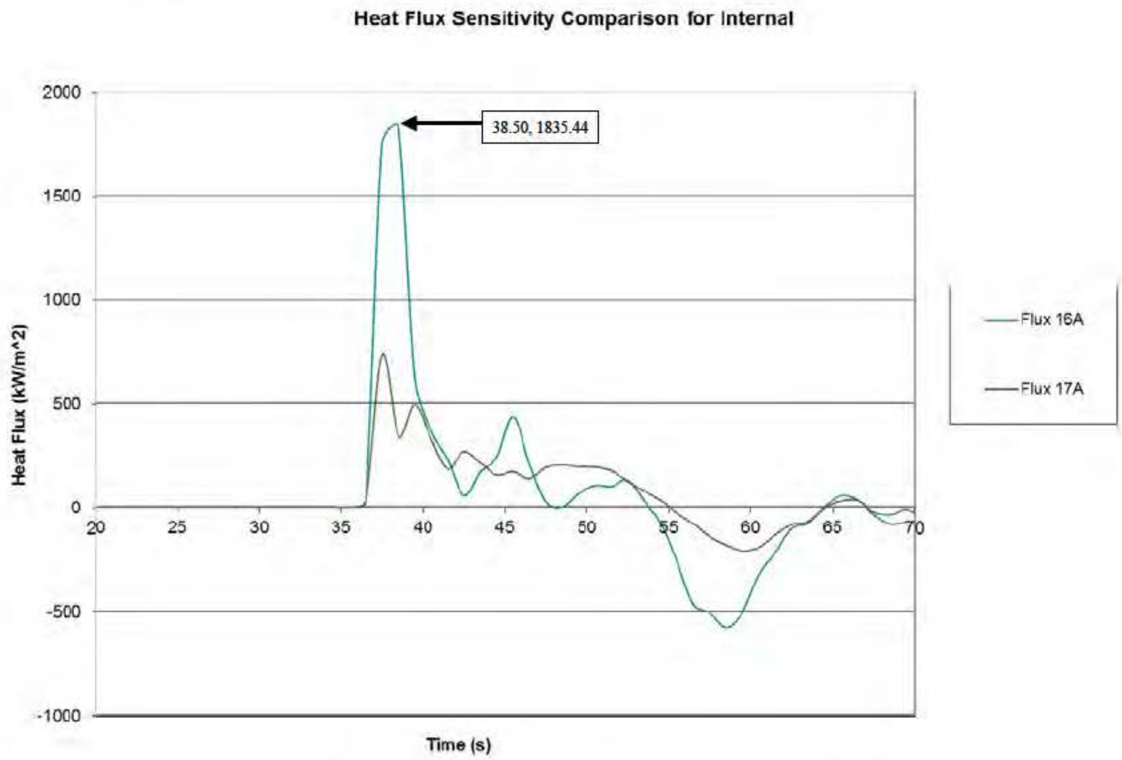

FIGURE II-5. Heat Flux Within Structure (Test 1).

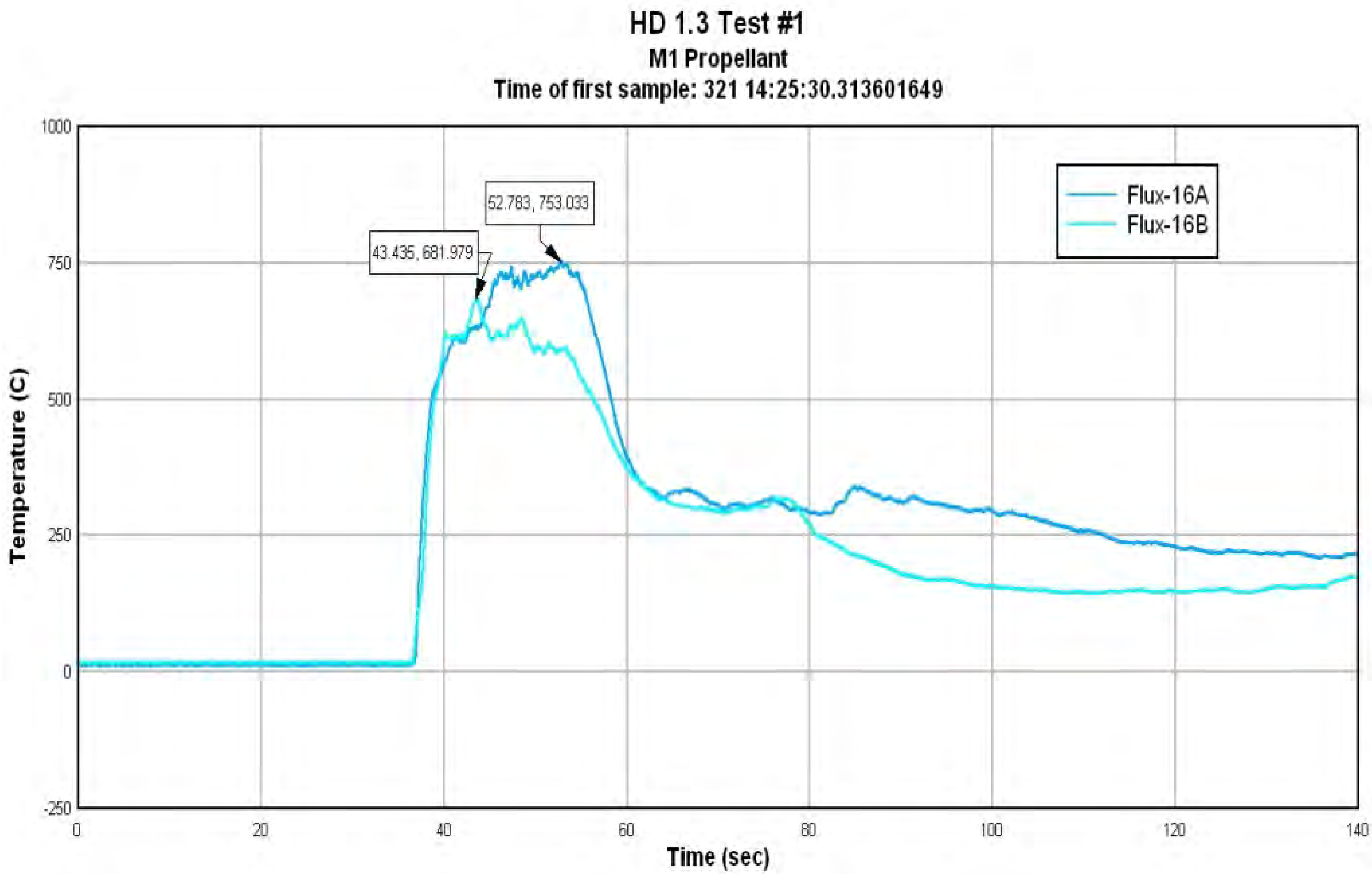

FIGURE II-6. Thermal Profiles From Heat Flux Gage 16 for Test 1.

Figure II-7 shows the residue of the three propellant drums inside the test structure.

FIGURE II-7. Residue of Three Drums That Contained M1 Propellant in Test 1, 16 November 2012.

OUTSIDE STRUCTURE

Figure II-8 shows evidence on the ground of the plume exiting the orifice and the location of heat flux gage 13.

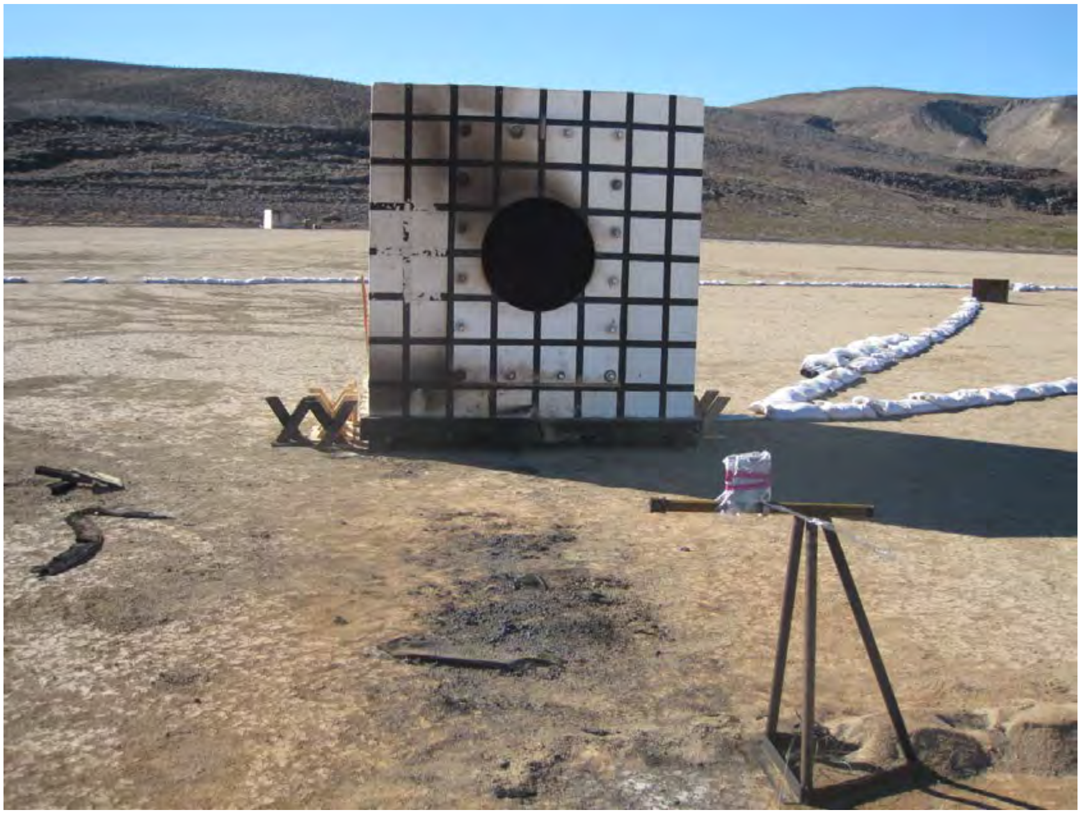

FIGURE II-8. Structure After Test 1 Showing
Evidence of Plume on Ground.

The maximum pressure outside the structure was 1.63 psi at 164 feet (50 meters) (Figure II-9).

The maximum heat flux measured outside the structure was approximately 4,347 kW/m^2 at 6.5 seconds measured at heat flux gage 13 that was located directly in the plume 15 feet from the orifice plate (Figure II-10).

The maximum heat flux measured at the other gages outside of direct plume exposure was approximately 5 kW/m^2. Using the heat flux gages, a maximum temperature of approximately 917^{o}C was observed external to the structure at 6.9 seconds and a distance of 15 feet (4.57 meters). The thermal trace shows a rapid temperature increase from ambient temperature (36°C) to above 500°C within 5.5 seconds of ignition. The temperature remains above 500°C for approximately 2.5 seconds before the gage fails. The heat flux gage at the mentioned location was inside the plume. Individuals exposed to the plume at that location would be a fatality. Figure II-11 provides the thermal profiles as determined from heat flux gages external to the structure.

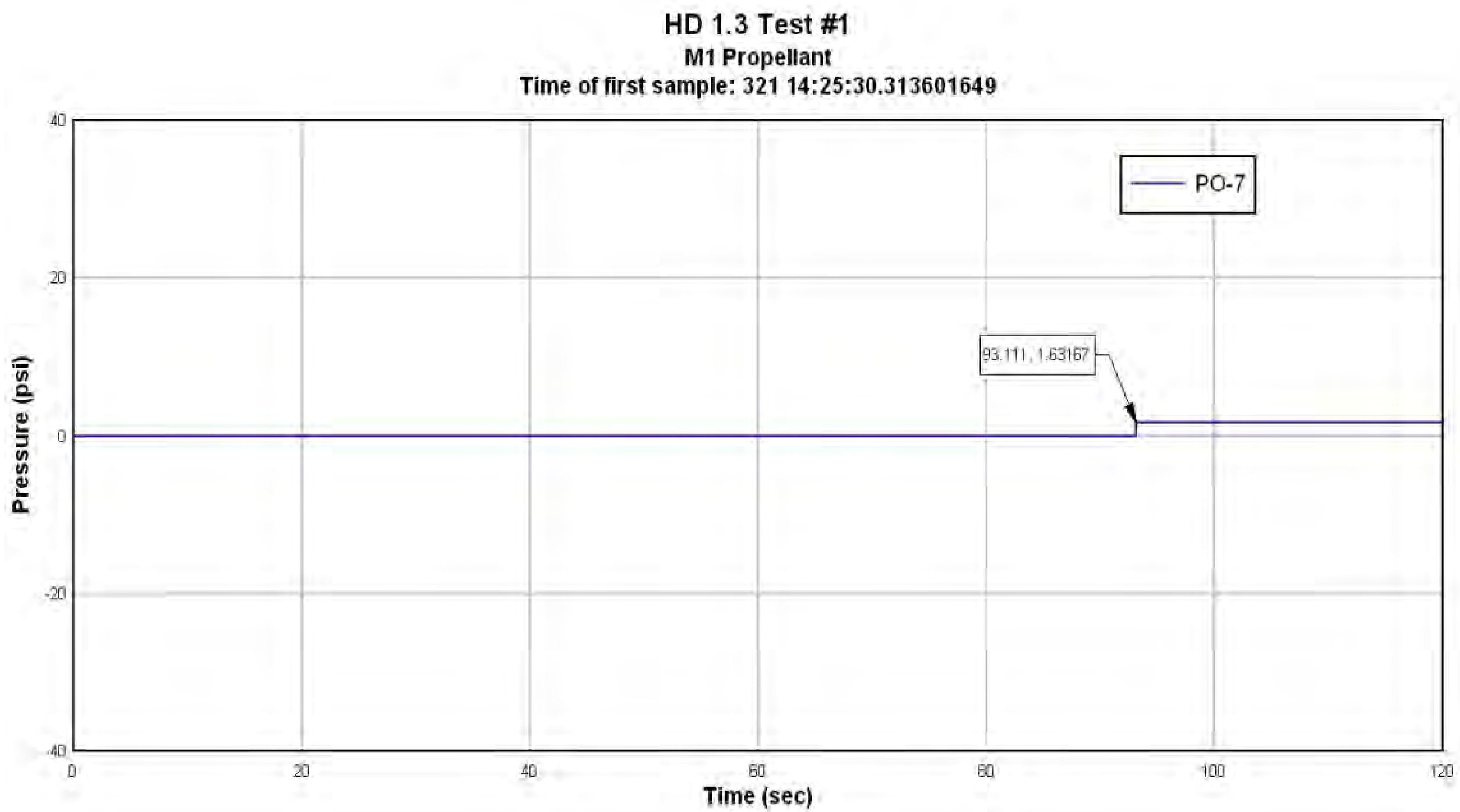

FIGURE II-9. External Pressure Profile at 164 Feet (Test 1).

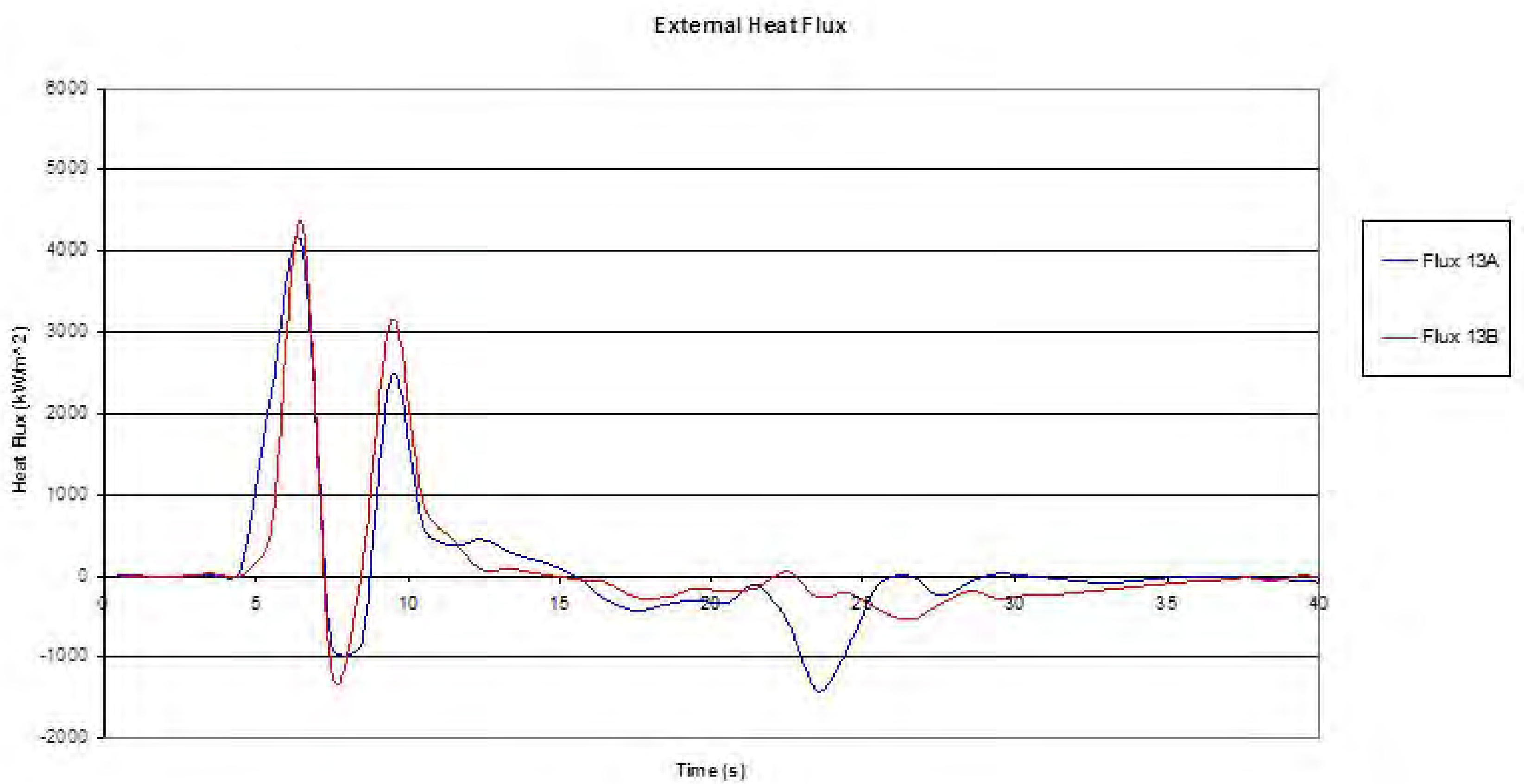

FIGURE II-10. Heat Flux Data Measured External to Structure (Test 1).

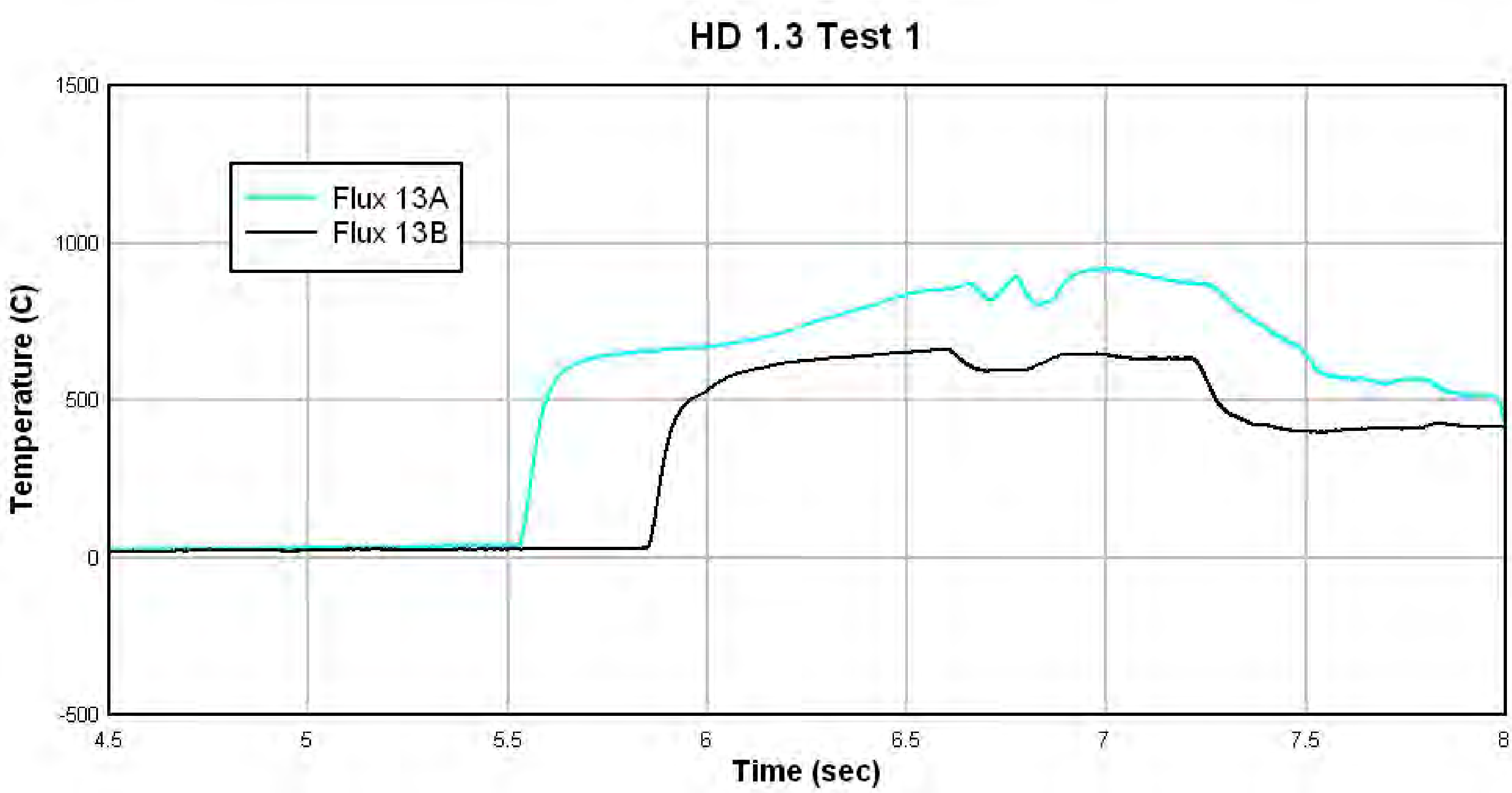

FIGURE II-11. Thermal Profile From Heat Flux
Gages External to Structure at 15 feet (Test1).

The combustion of the drums of M1 propellant produced a large plume outside the structure. The plume lasted for approximately 26 seconds. Figures II-12, II-13, and II-14 depict still pictures taken from the high-speed video showing the plume exiting the orifice seconds after ignition. The camera footage from the high-speed cameras can be found in Appendix II-C.

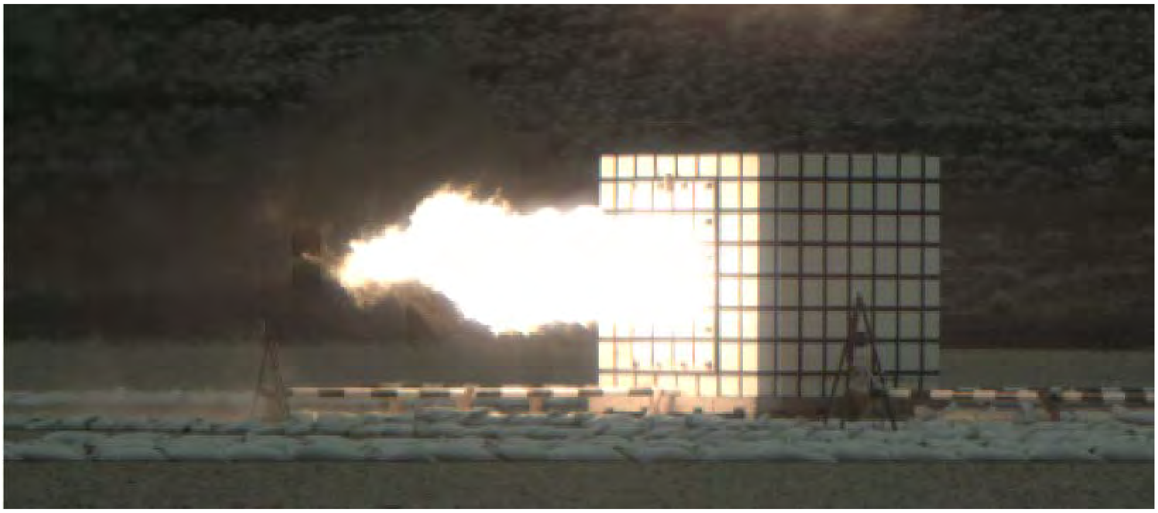

FIGURE II-12. Plume in Test 1 at 1.25 Seconds After Ignition.

FIGURE II-13. Plume in Test 1 at 8.6 Seconds After Ignition.

FIGURE II-14. Plume in Test 1 at 26.78 Seconds After Ignition.

Test 1 was also instrumented with Doppler radar technology. Doppler radar is typically used to gather data on the velocity of fragments and other debris. The Doppler radar was used to determine the duration and velocity of the plume in Test 1. The plume was first detected at a velocity of 25 m/s and increased to 90 m/s before extinguishment. The duration of the plume was 18 seconds. An example of a Doppler intensity plot for Test 4 is shown in Figure II-15. Additional plots are provided in Appendix II-D.

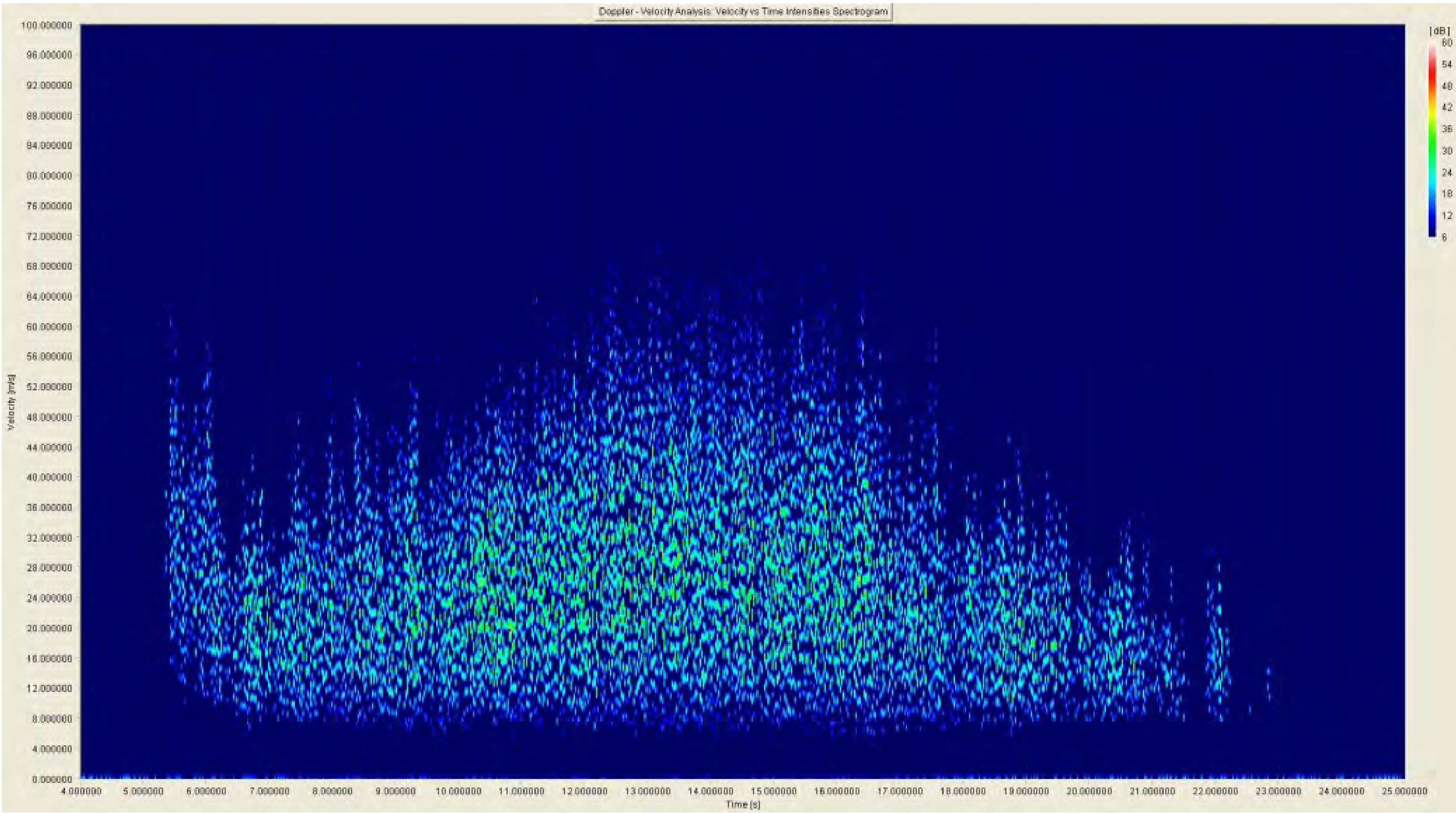

FIGURE II-15. Doppler Intensity Plot for Test 1.

TEST 1/CONCLUSIONS AND RECOMMENDATIONS

Test 1 was the first of a series of tests designed to examine the effect of an HD1.3 energetic material burning in a concrete structure. M1 propellant was the test sample. Test 1 was performed with a 79-cm-diameter orifice in the face plate of the structure, resulting in a vent area ratio of 0.122. The large vent area and relatively low propellant loading density (16.78 kg/m^2) resulted in an unchoked venting condition and no structural failure.

The hazards from the pressure of the unchoked flow are insignificant; peak pressures of 2 psi were observed within the structure and less than 1 psi was observed outside the structure. A pressure of 0.95 psi is required to cause minimal damage (ear drum rupture) to a human (References II-1 and II-2).

The velocity of the plume was determined using the Doppler data; reaching a maximum velocity of 90 m/s.

Far field thermal flux data were lost in Test 1; however, the Doppler, pressure, and thermal data inside the structure were collected and can be coupled with the visual camera data to begin the quantification of the hazards associated with HD1.3 thermal events. The results of Test 1 begin to improve the resolution in predicting the hazards associated with items classified as HD1.3 mass fire.

High-speed cameras provided visuals of the plume that were used to measure a plume length greater than 5 meters for the plume prior to exceeding the field of view. In the following tests, the camera placement was relocated from a position showing a view of the corner of the structure to a position with the angle between the wall of the structure and the camera at 90 degrees with a wider field of view. This minor repositioning improved the ability for the cameras to gather plume length and better observe the behavior of the structure. The repositioning also allowed for the use of the painted fiducials on the walls of the structure as a reference point between the items.

As this test series progressed, we coupled the different types of data to provide a more complete picture of the hazards associated with the unexpected ignition of HD1.3 materials in the described storage configuration.

Test 3 was a duplication of this test with the exception of the difference in propellant grain geometry and was used to confirm the results of Test 1. Modifications to Test 3 were made to improve the instrumentation and data collection.

REFERENCES

II-1. S. Glasstone and P. J. Dolan, eds. *The Effects of Nuclear Weapons*. 3rd ed. Washington, DC, U.S. Department of Defense and the Energy Research and Development Administration, 1977. 662 pp.

II-2. U.S. Department of the Army. *Structures to Resist the Effects of Accidental Explosions*. Washington, DC, Departments of the Army, Navy, and Air Force, 1990. (Army TM 5-1300, Navy NAVFAC P-397, AFR 88-2, publication UNCLASSIFIED.)

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Appendix II-A

HD1.3 TEST 1. PRESSURE AND BREAK WIRE DATA

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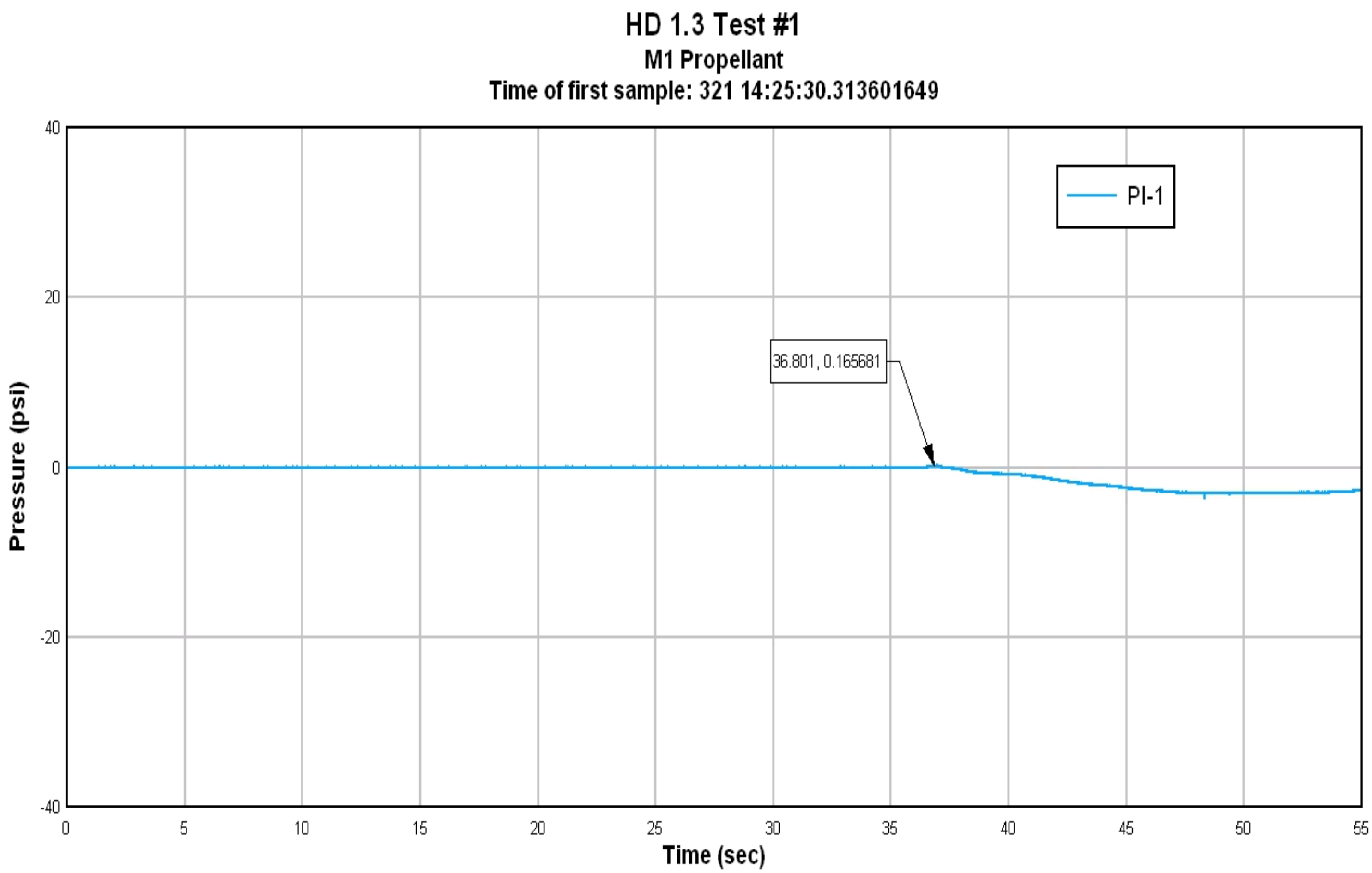

FIGURE II-A-1. Internal Pressure Gage #1.

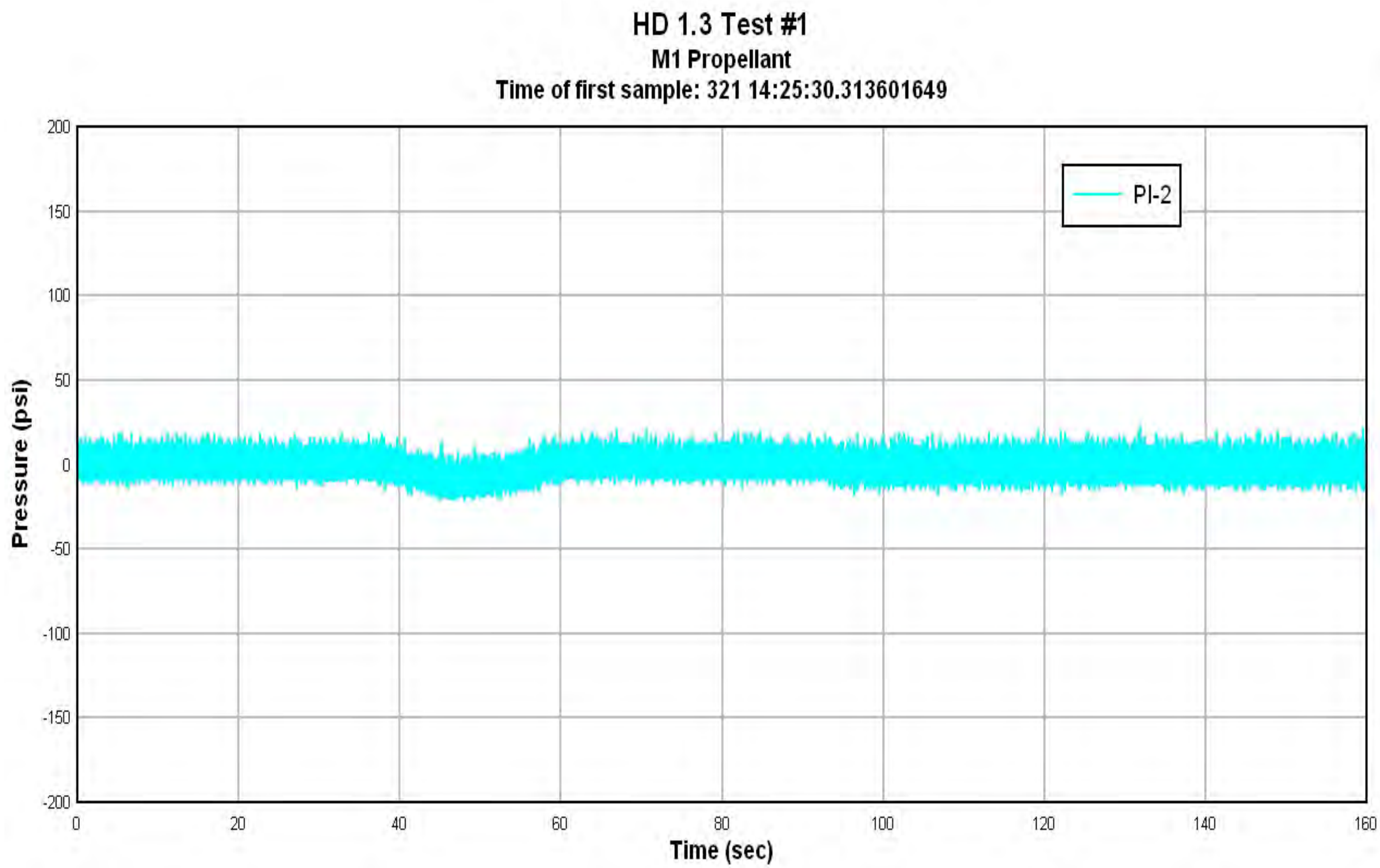

FIGURE II-A-2. Internal Pressure Gage #2.

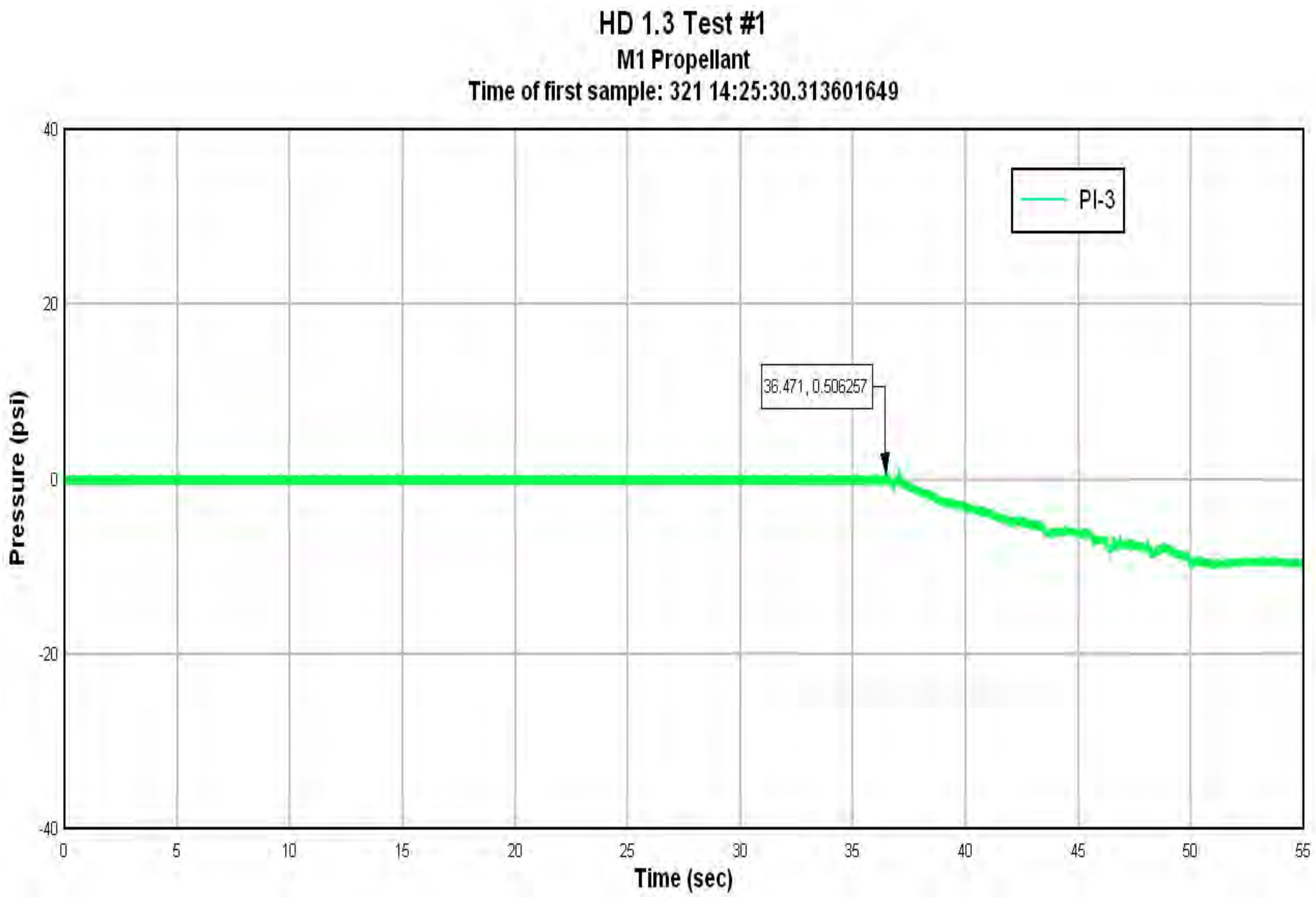

FIGURE II-A-3. Internal Pressure Gage #3.

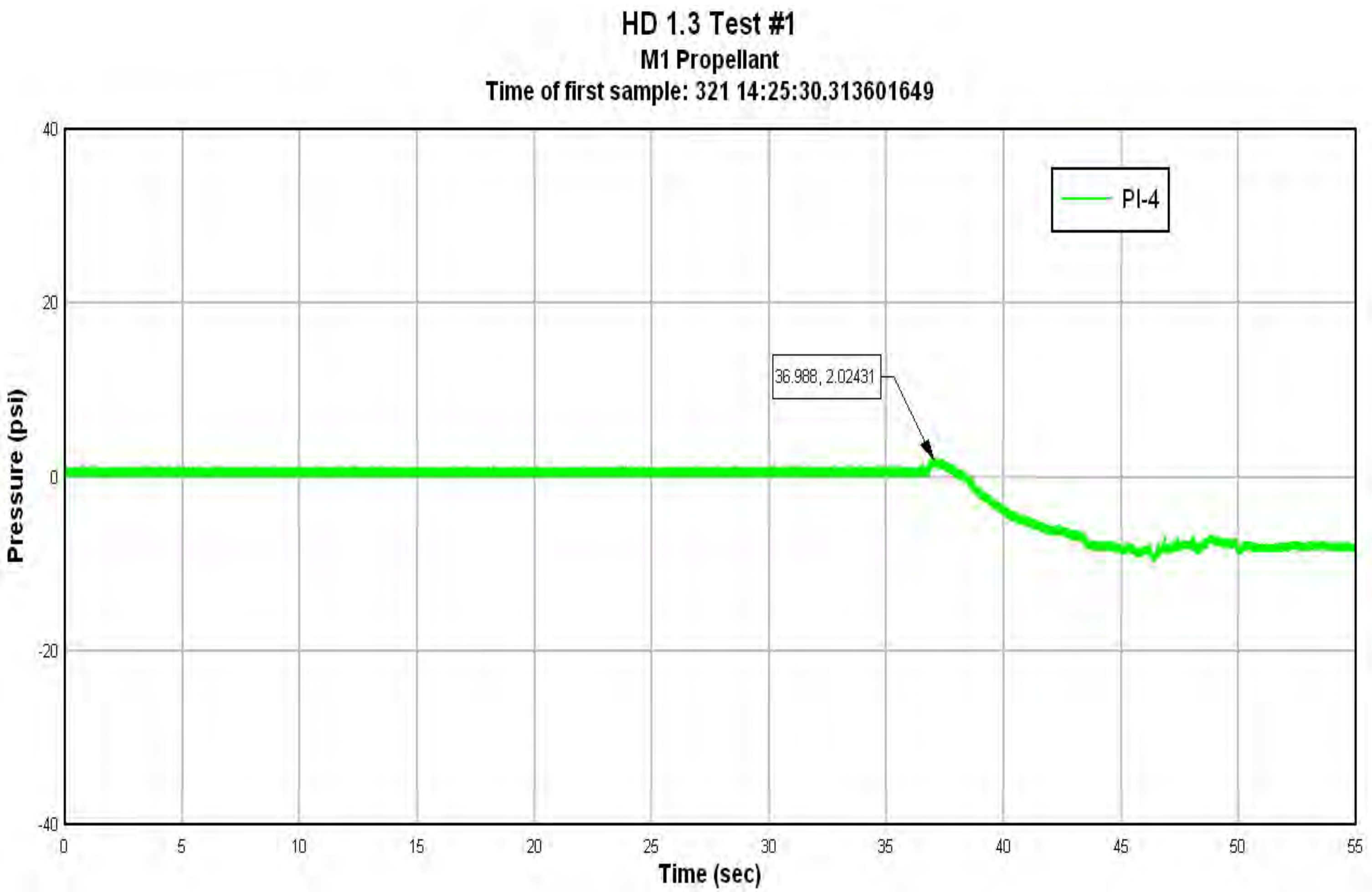

FIGURE II-A-4. Internal Pressure Gage #4.

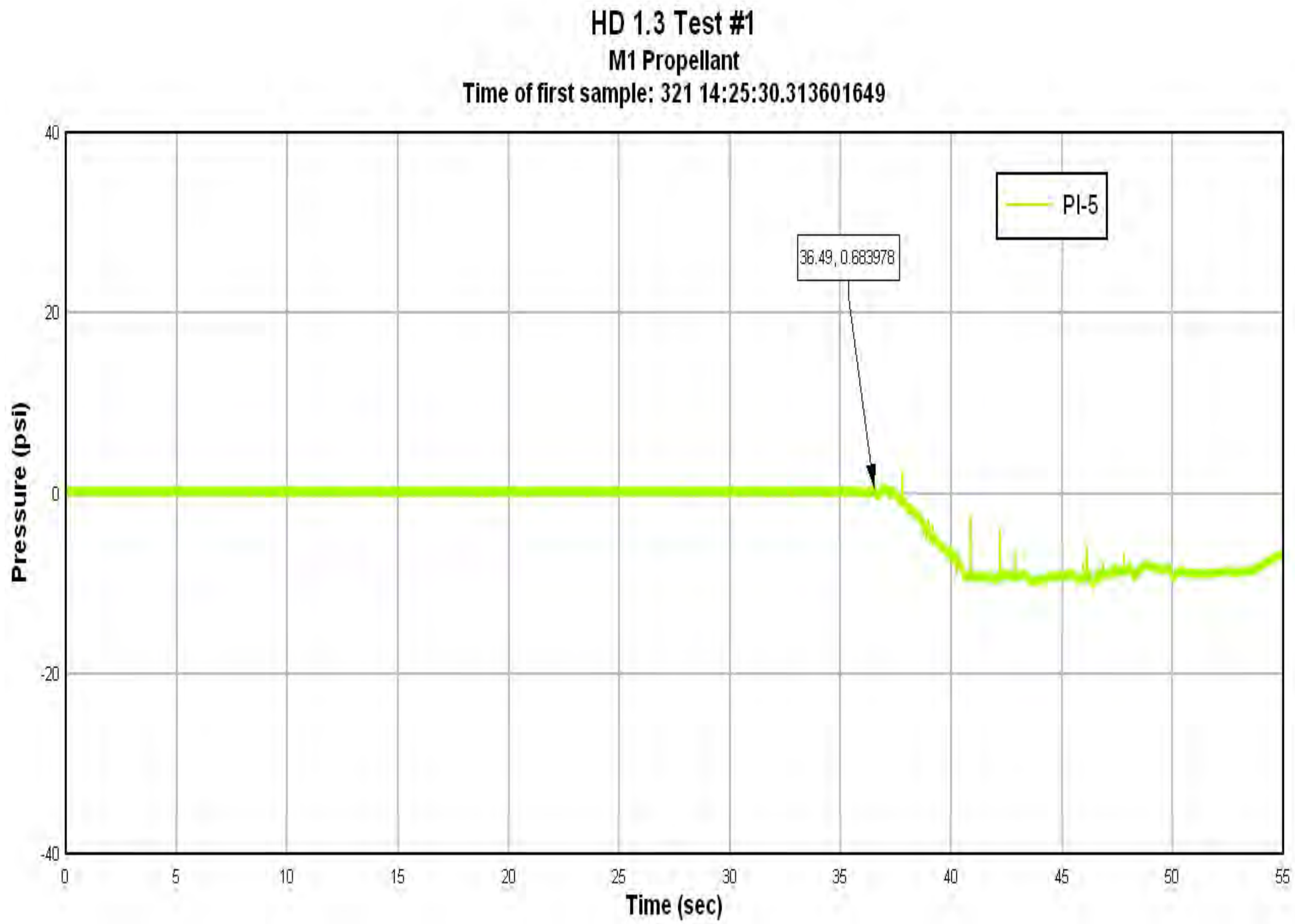

FIGURE II-A-5. Internal Pressure Gage #5.

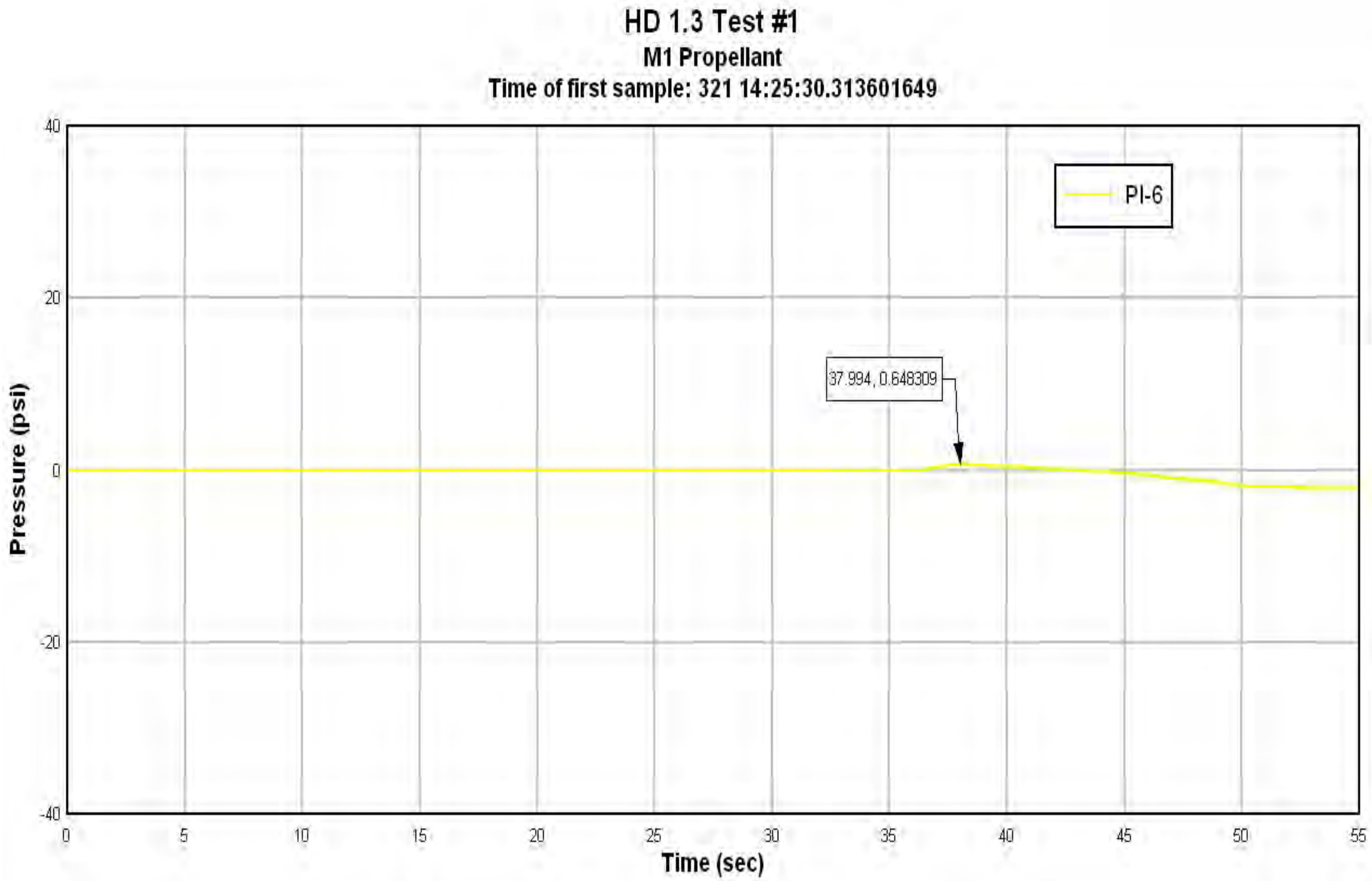

FIGURE II-A-6. Internal Pressure Gage #6.

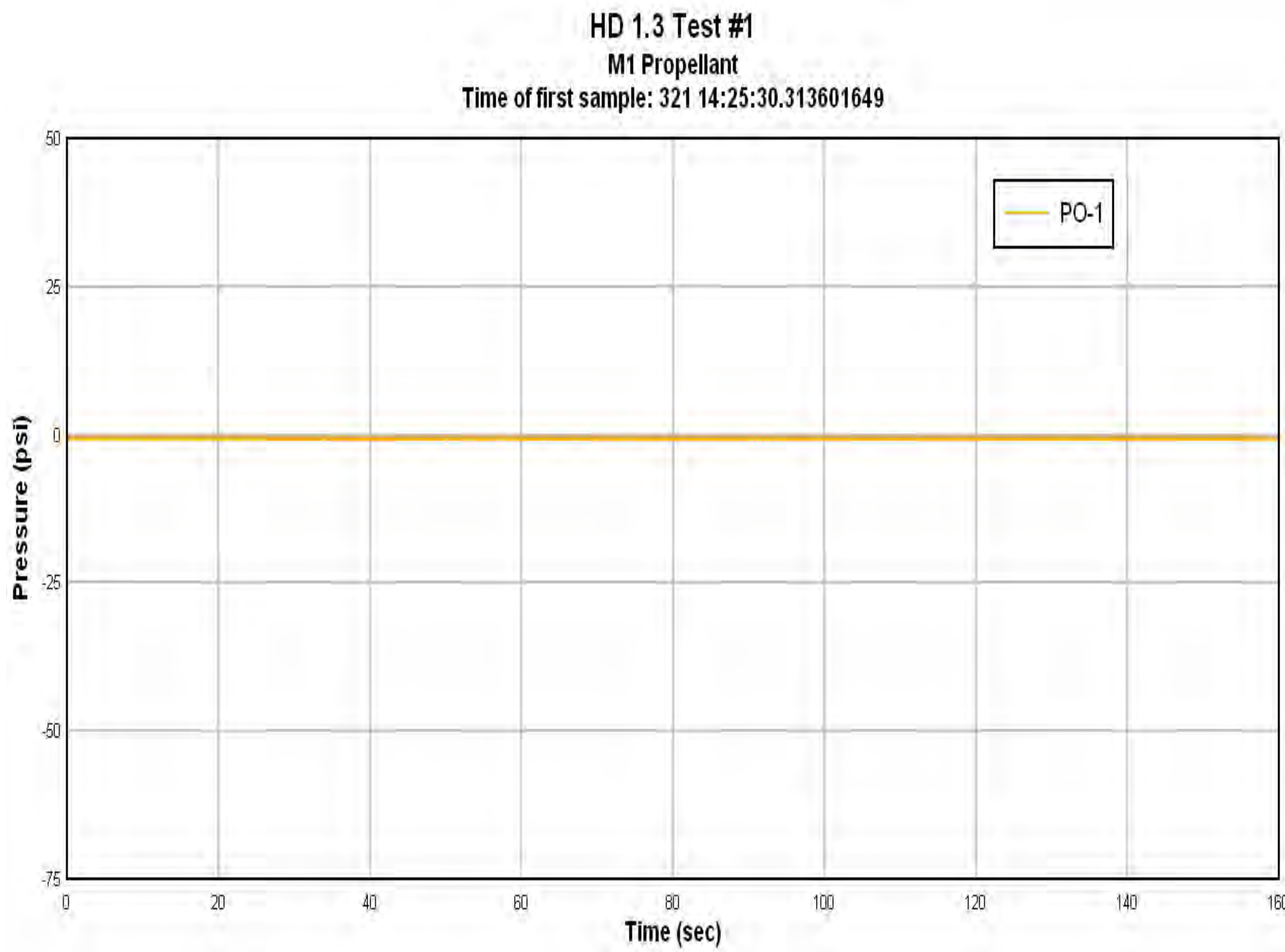

FIGURE II-A-7. External Pressure Gage #1.

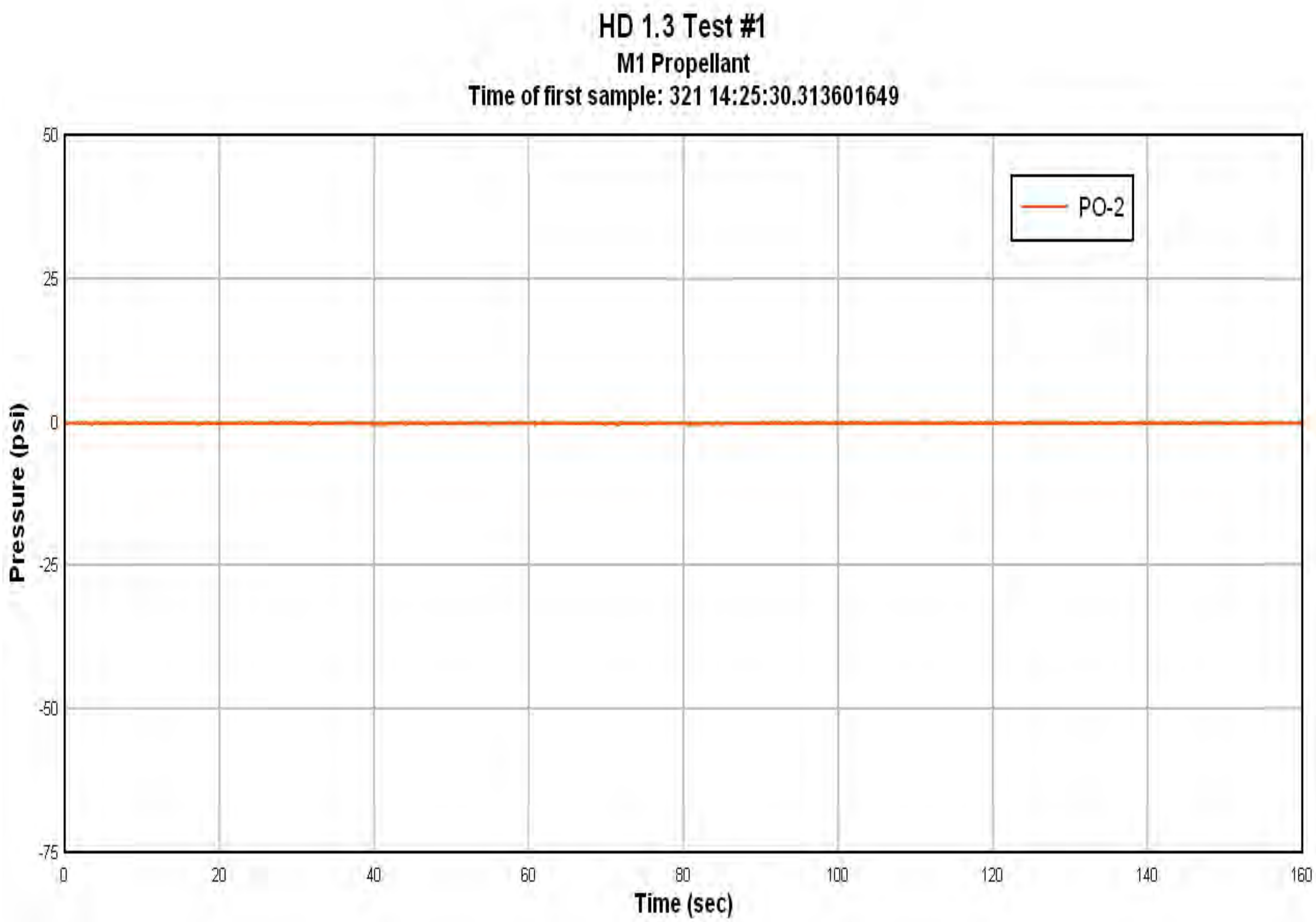

FIGURE II-A-8. External Pressure Gage #2.

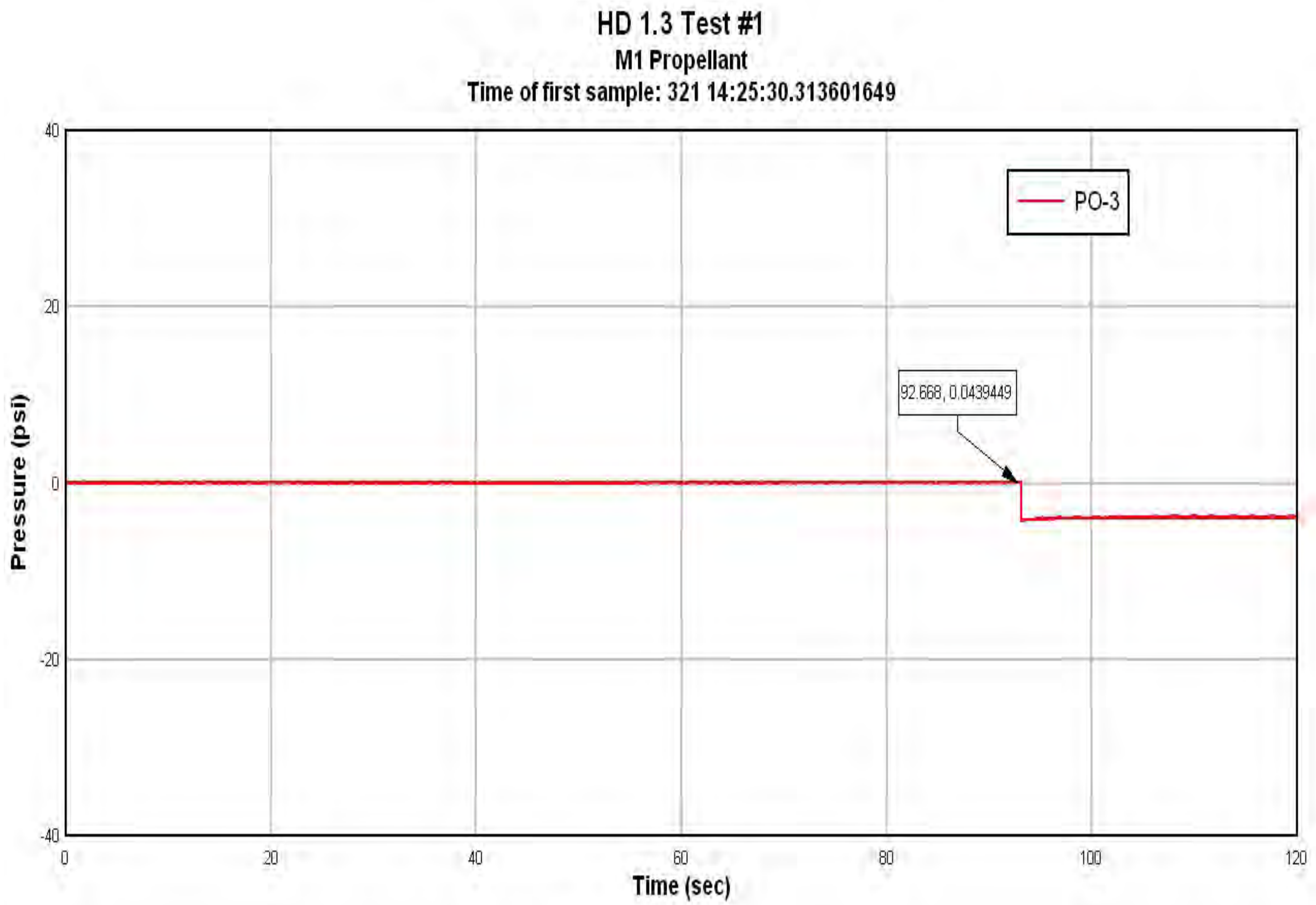

FIGURE II-A-9. External Pressure Gage #3.

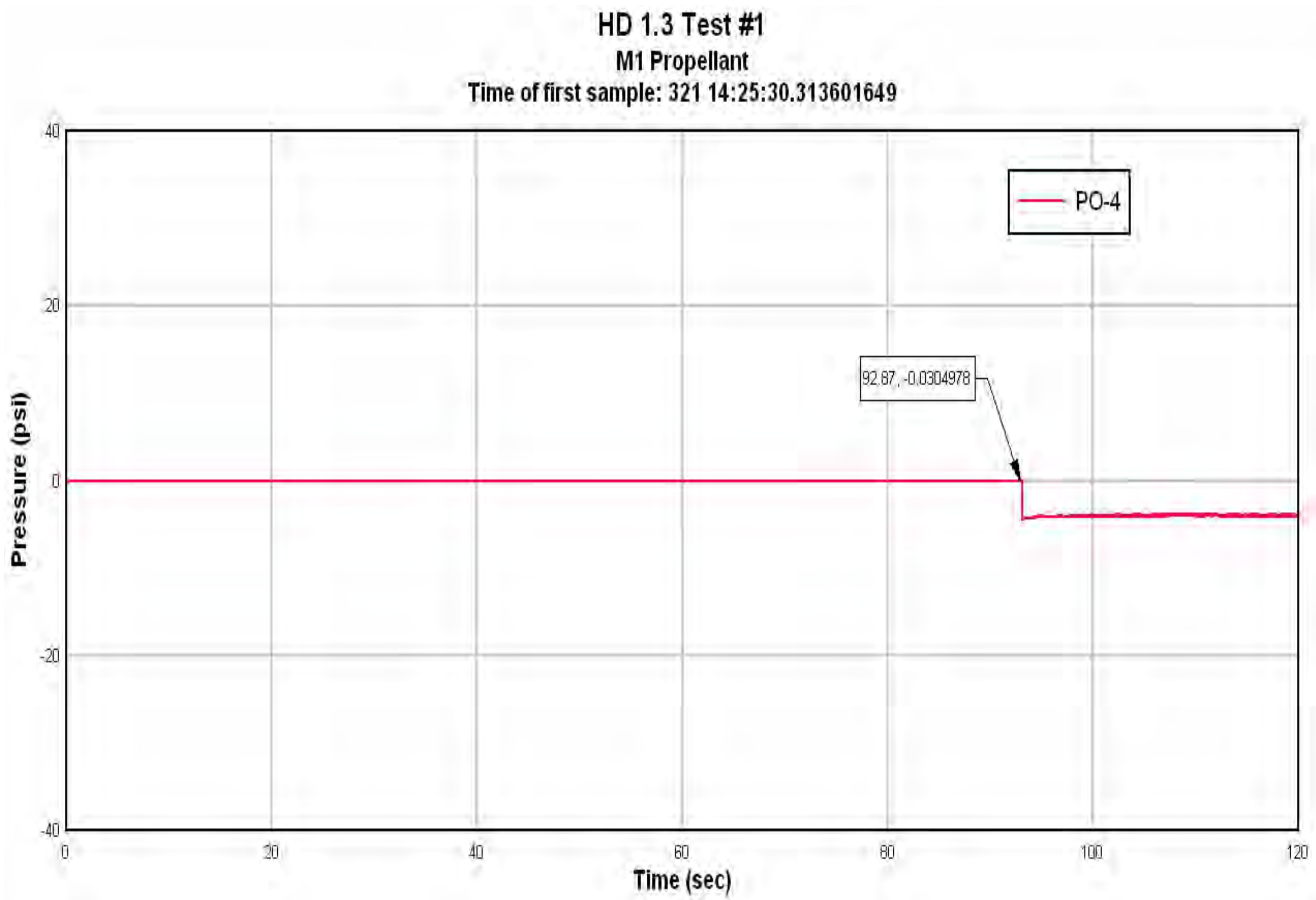

FIGURE II-A-10. External Pressure Gage #4.

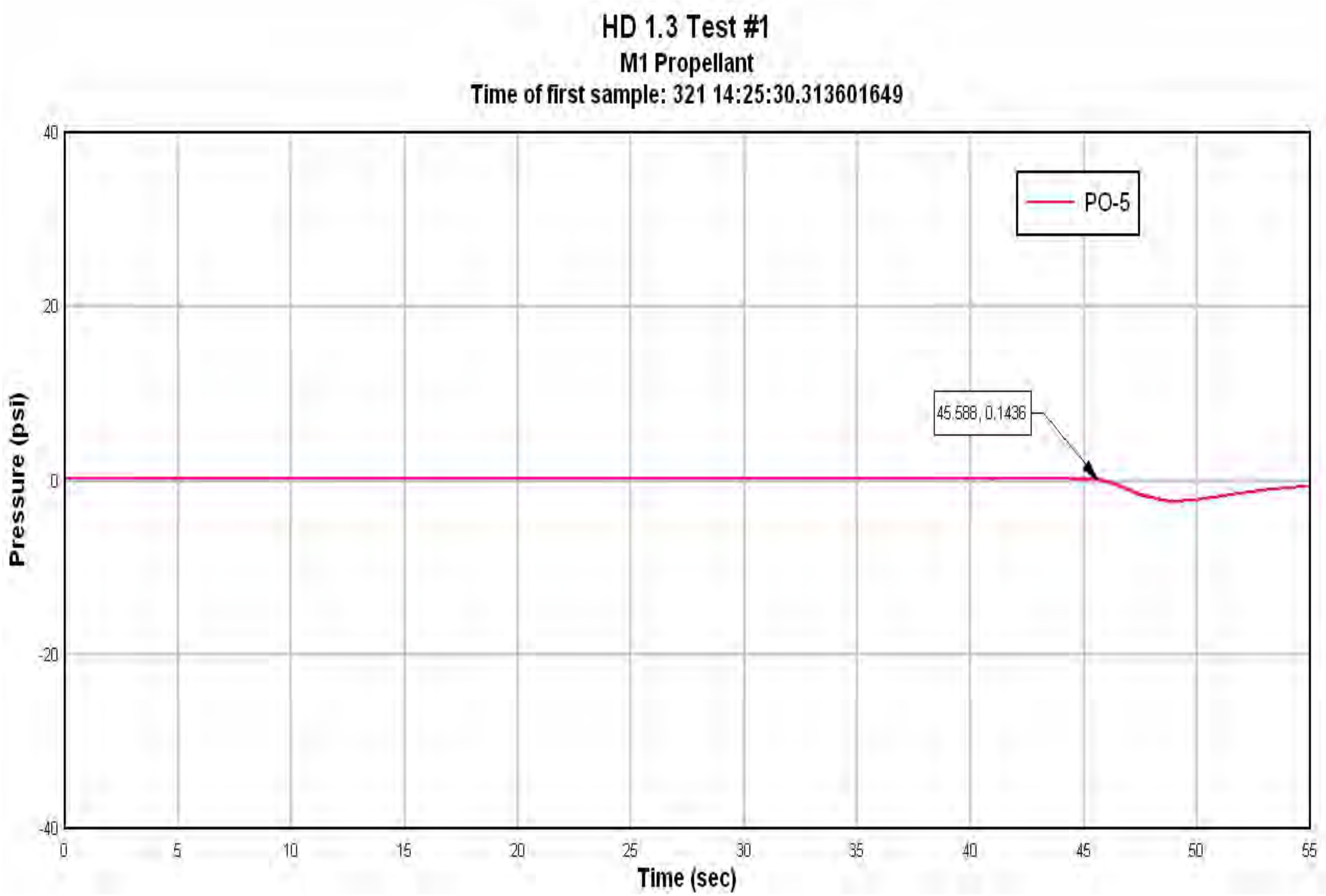

FIGURE II-A-11. External Pressure Gage #5.

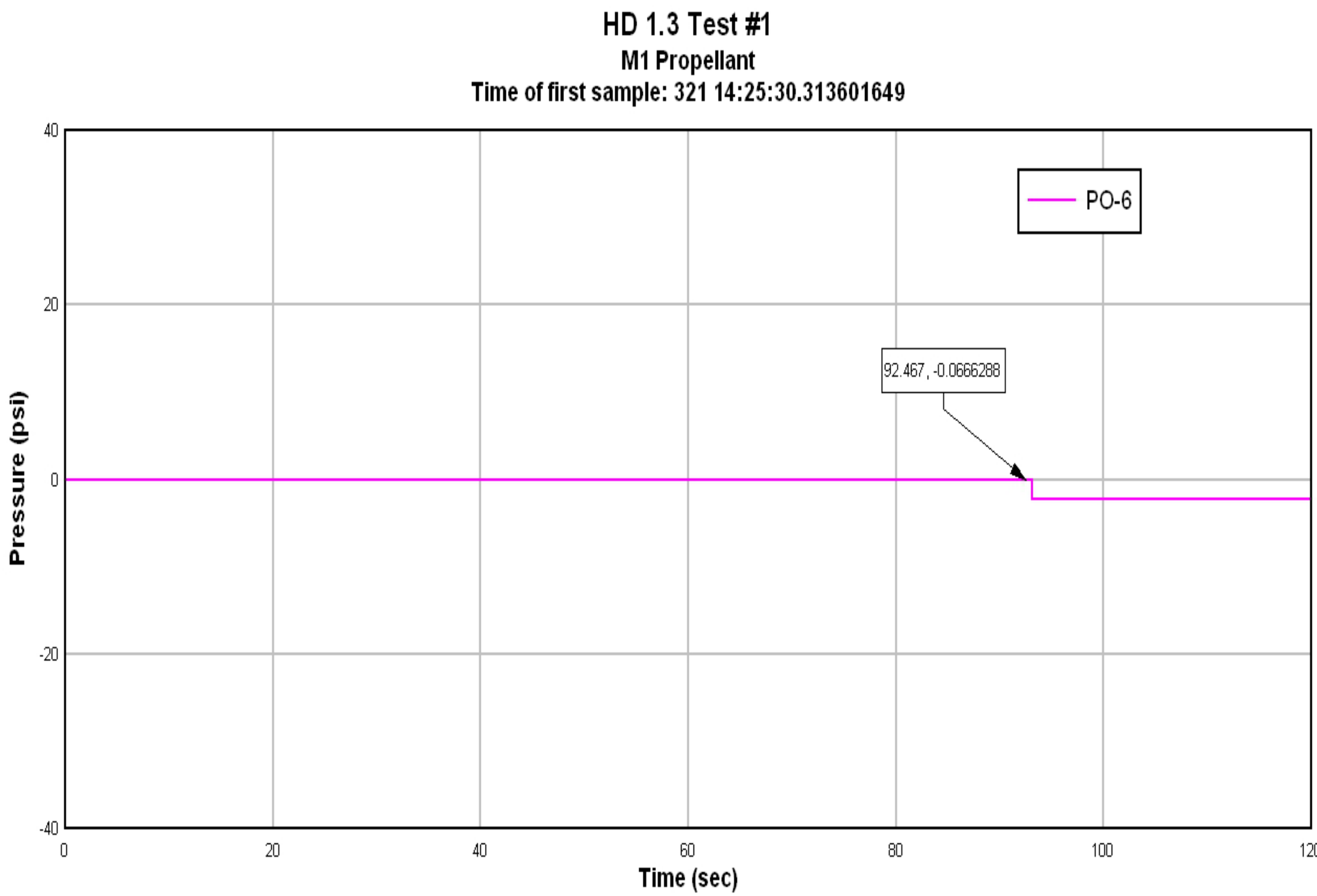

FIGURE II-A-12. External Pressure Gage #6.

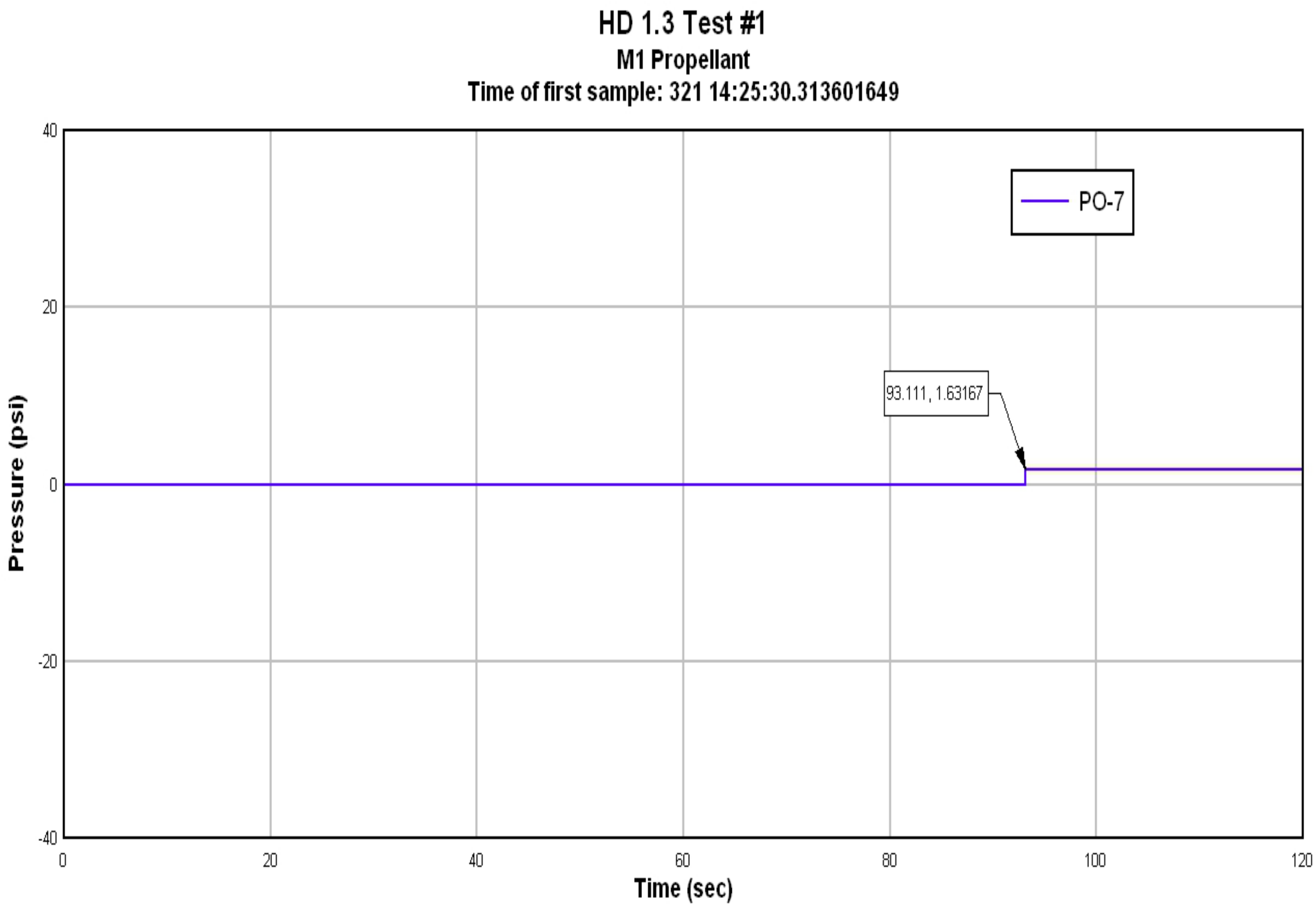

FIGURE II-A-13. External Pressure Gage #7.

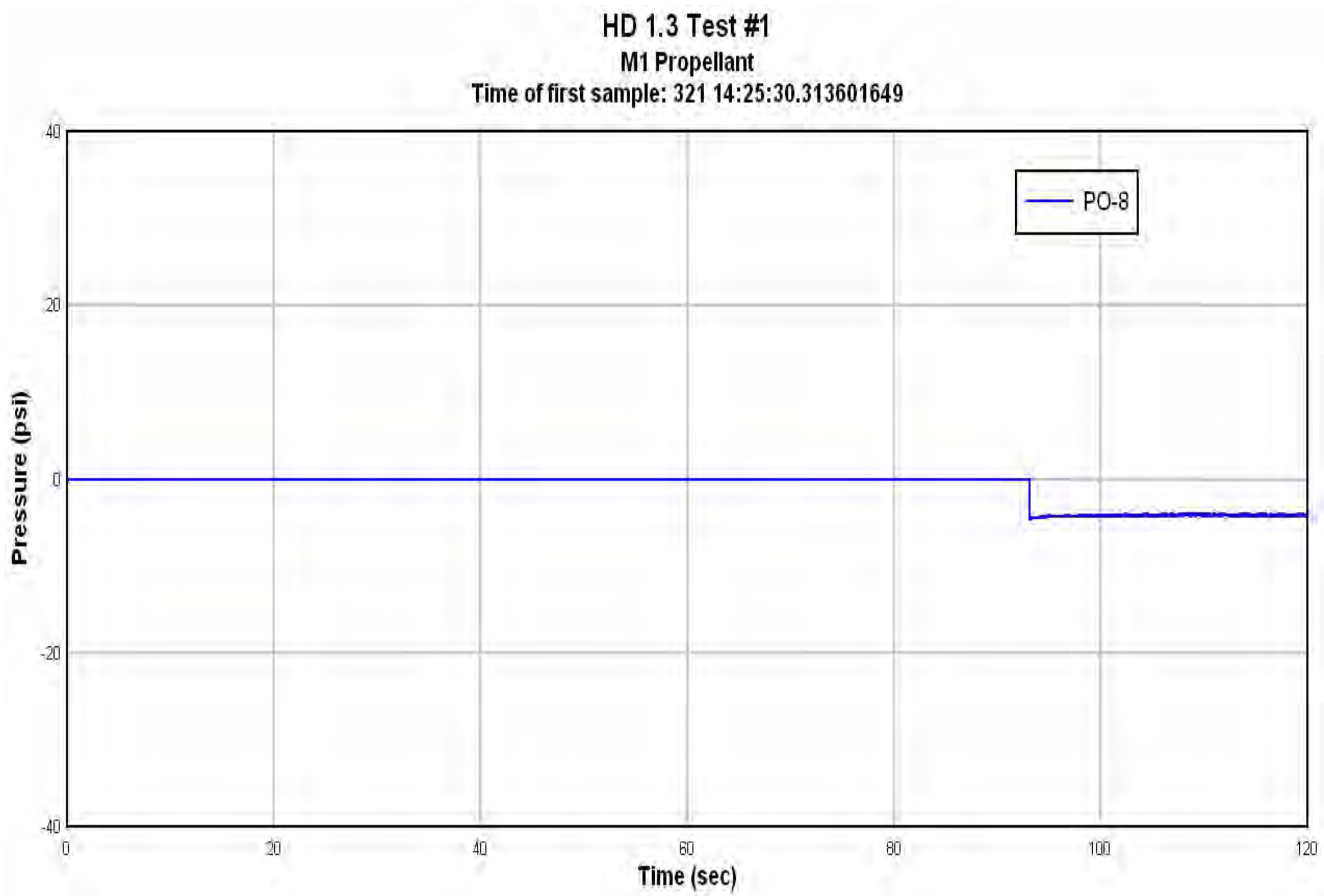

FIGURE II-A-14. External Pressure Gage #8.

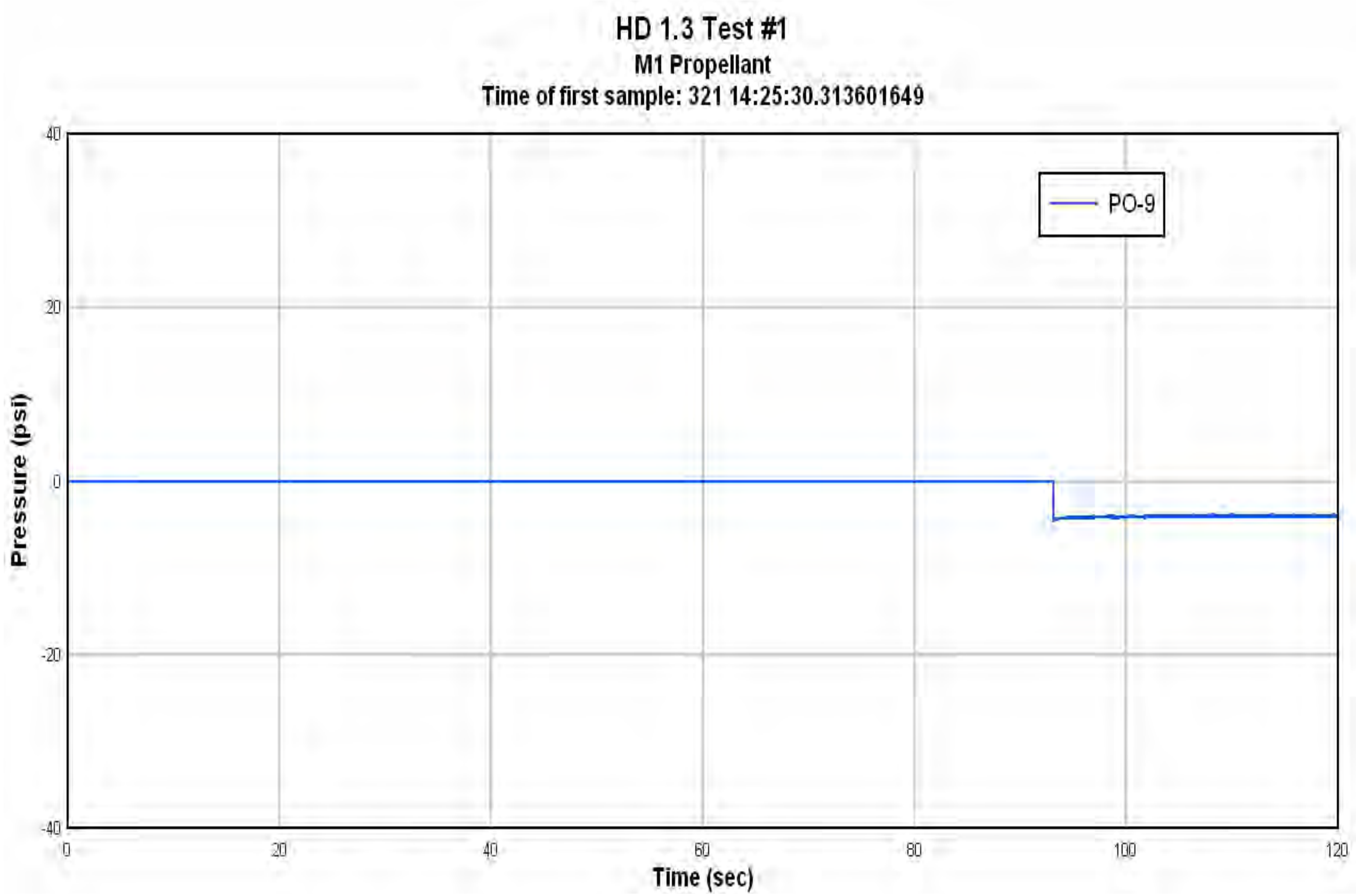

FIGURE II-A-15. External Pressure Gage #9.

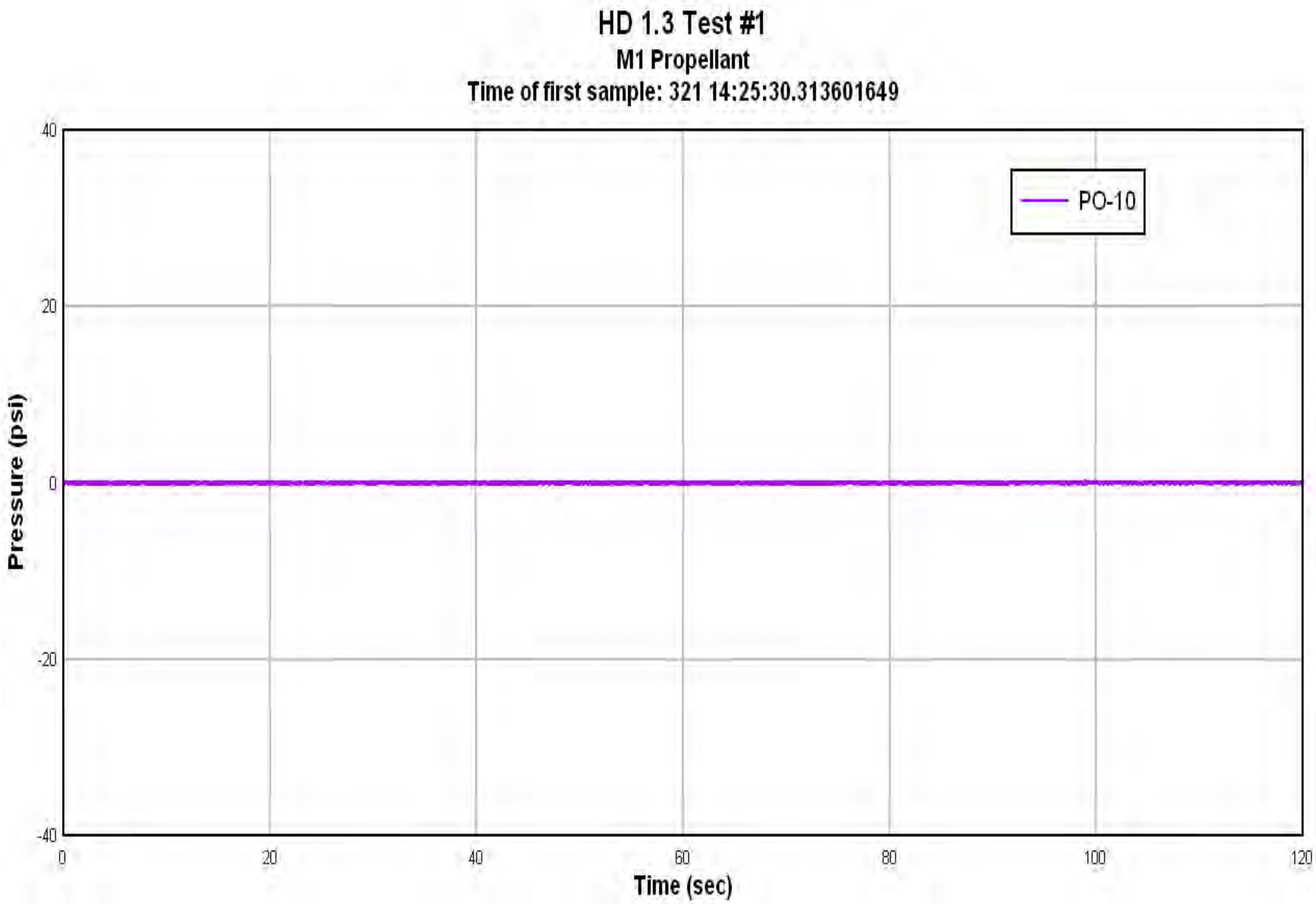

FIGURE II-A-16. External Pressure Gage #10.

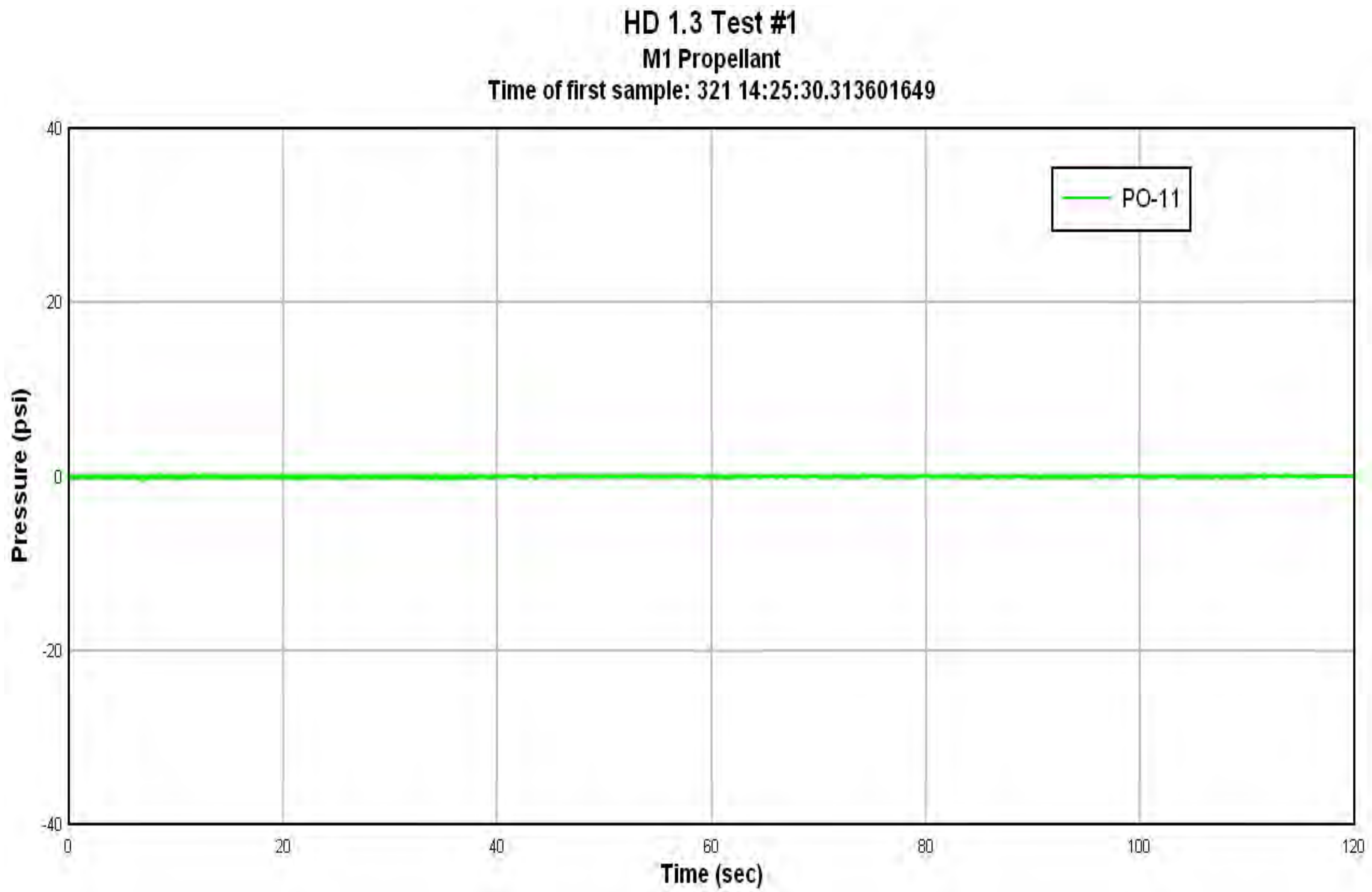

FIGURE II-A-17. External Pressure Gage #11.

SUMMARY

- Peak Internal Pressure 2.02 psi at gage 4 at 37 seconds (36.988).
- Peak External Pressure 1.63 psi at gage 7 at 93 seconds (93.111).

Break Wire Inside the Structure

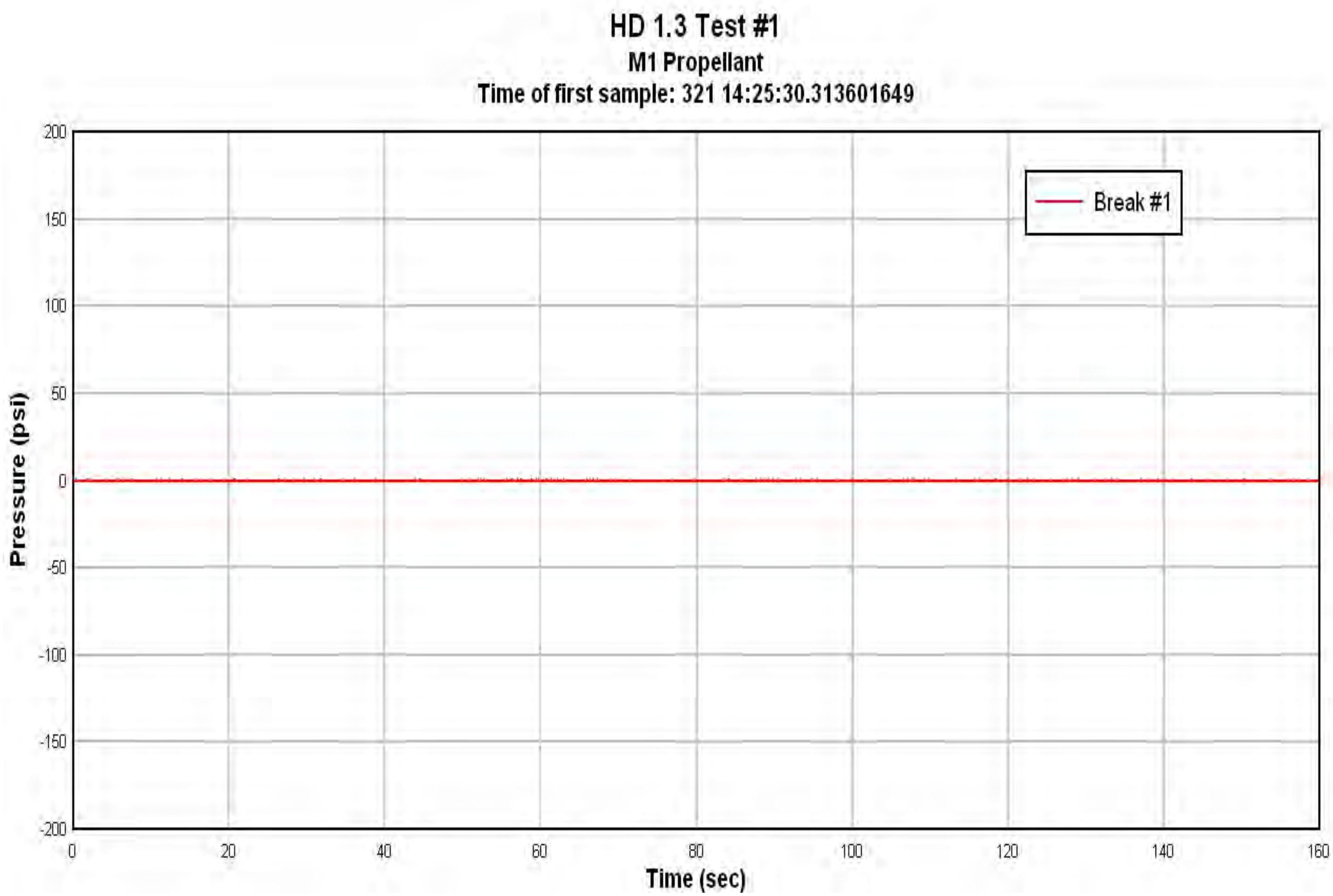

FIGURE II-A-18. Break Wire #1.

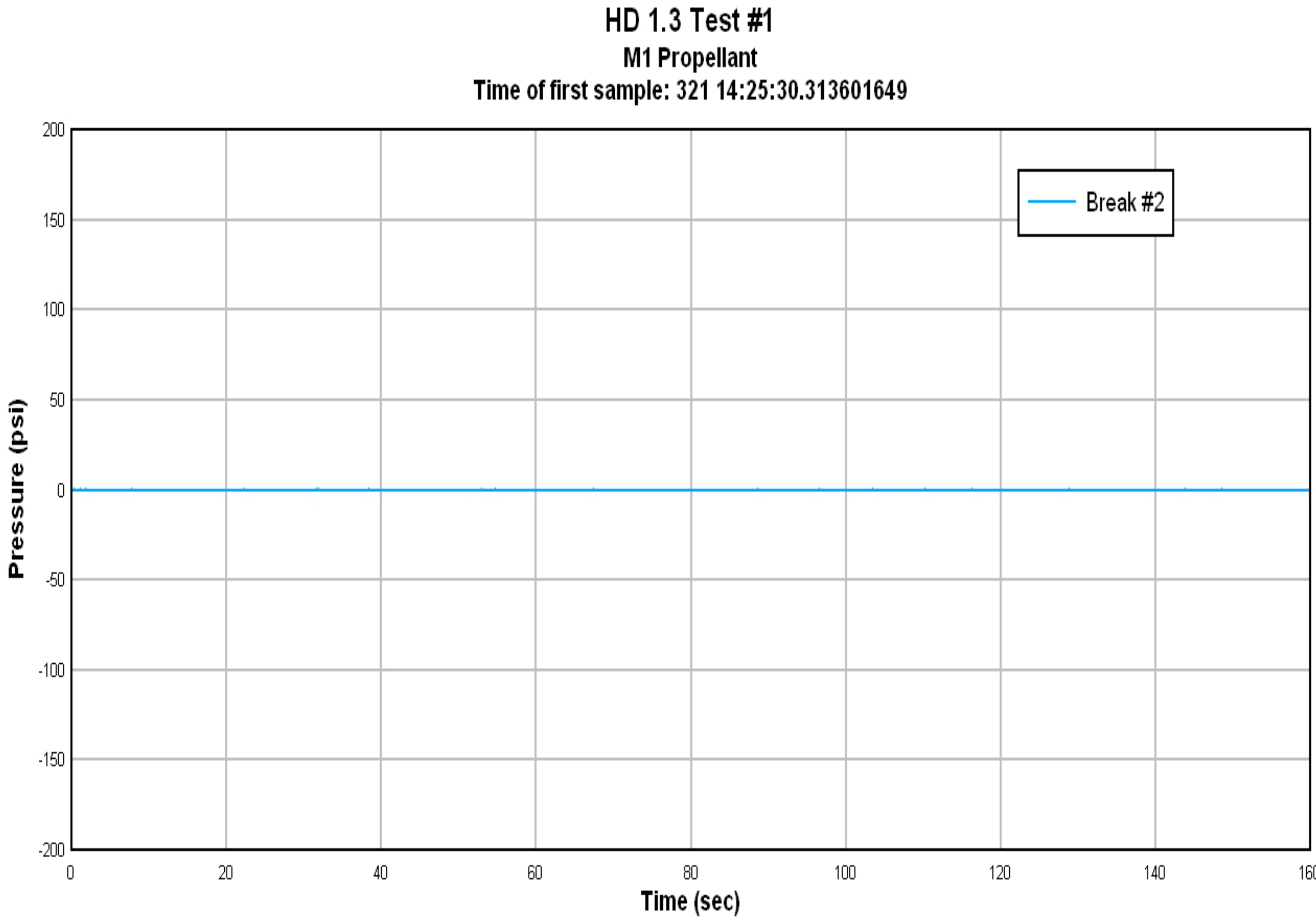

FIGURE II-A-19. Break Wire #2.

Appendix II-B

HD1.3 TEST 1. TEMPERATURE AND FLUX DATA

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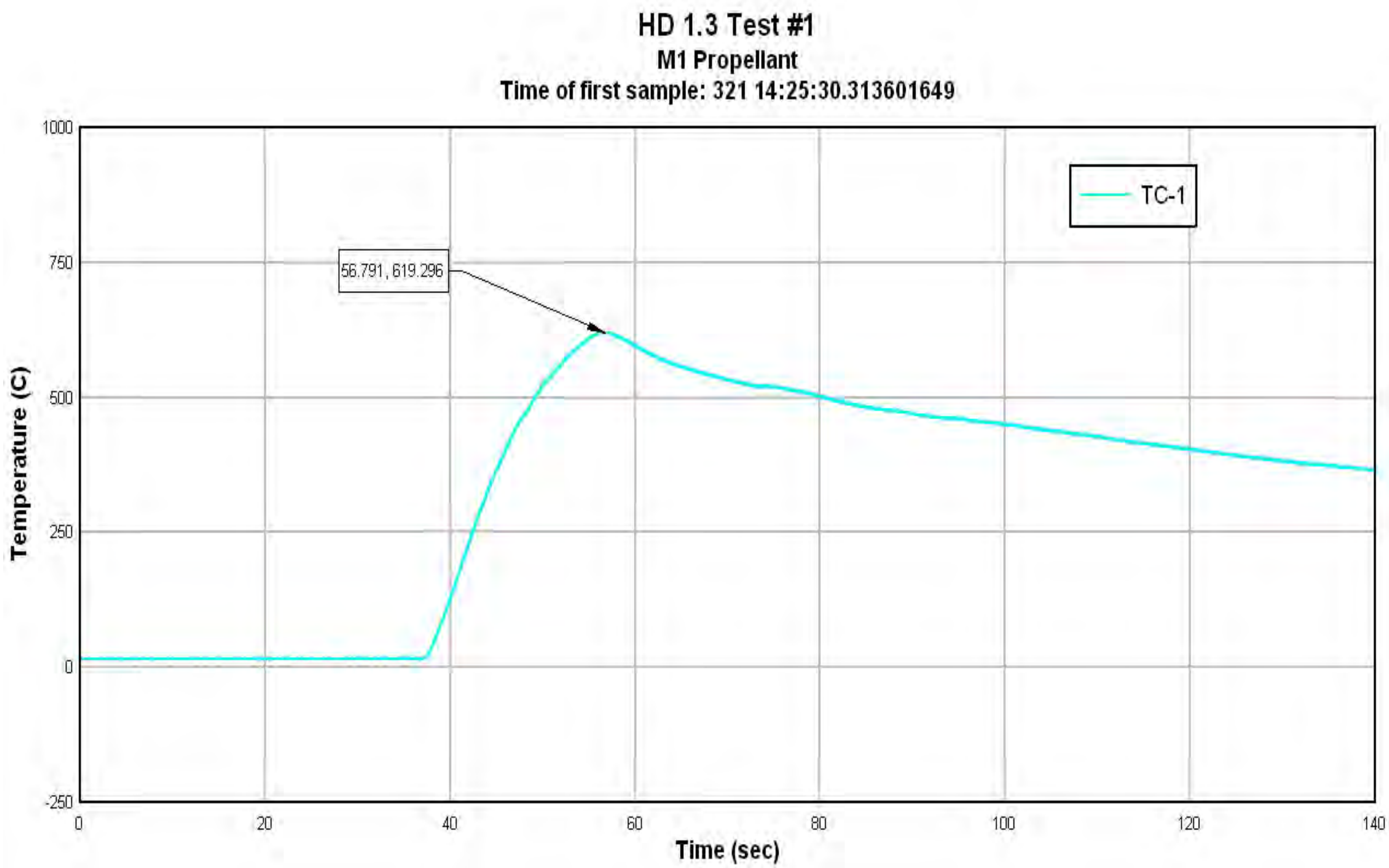

FIGURE II-B-1. Thermocouple #1.

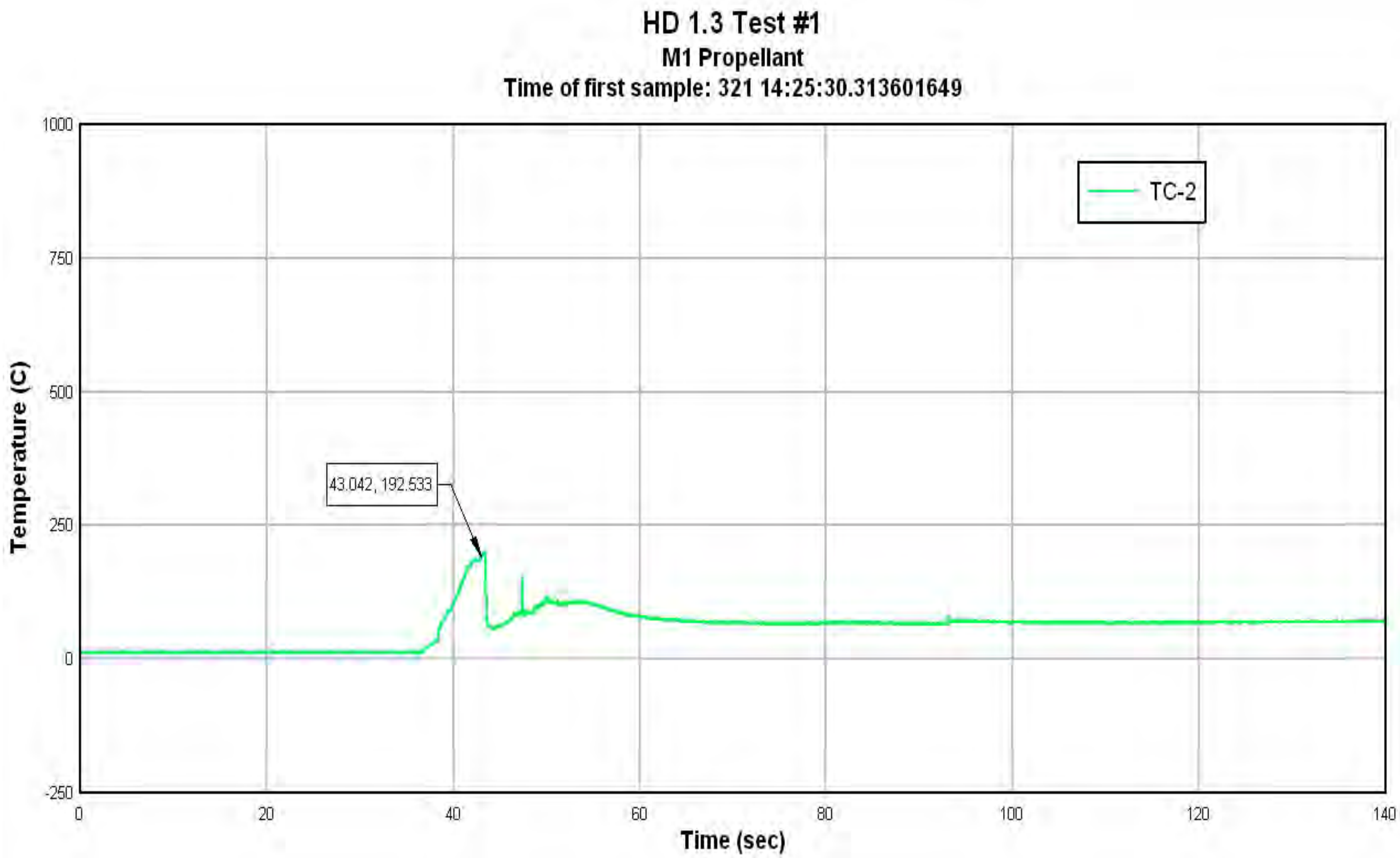

FIGURE II-B-2. Thermocouple #2.

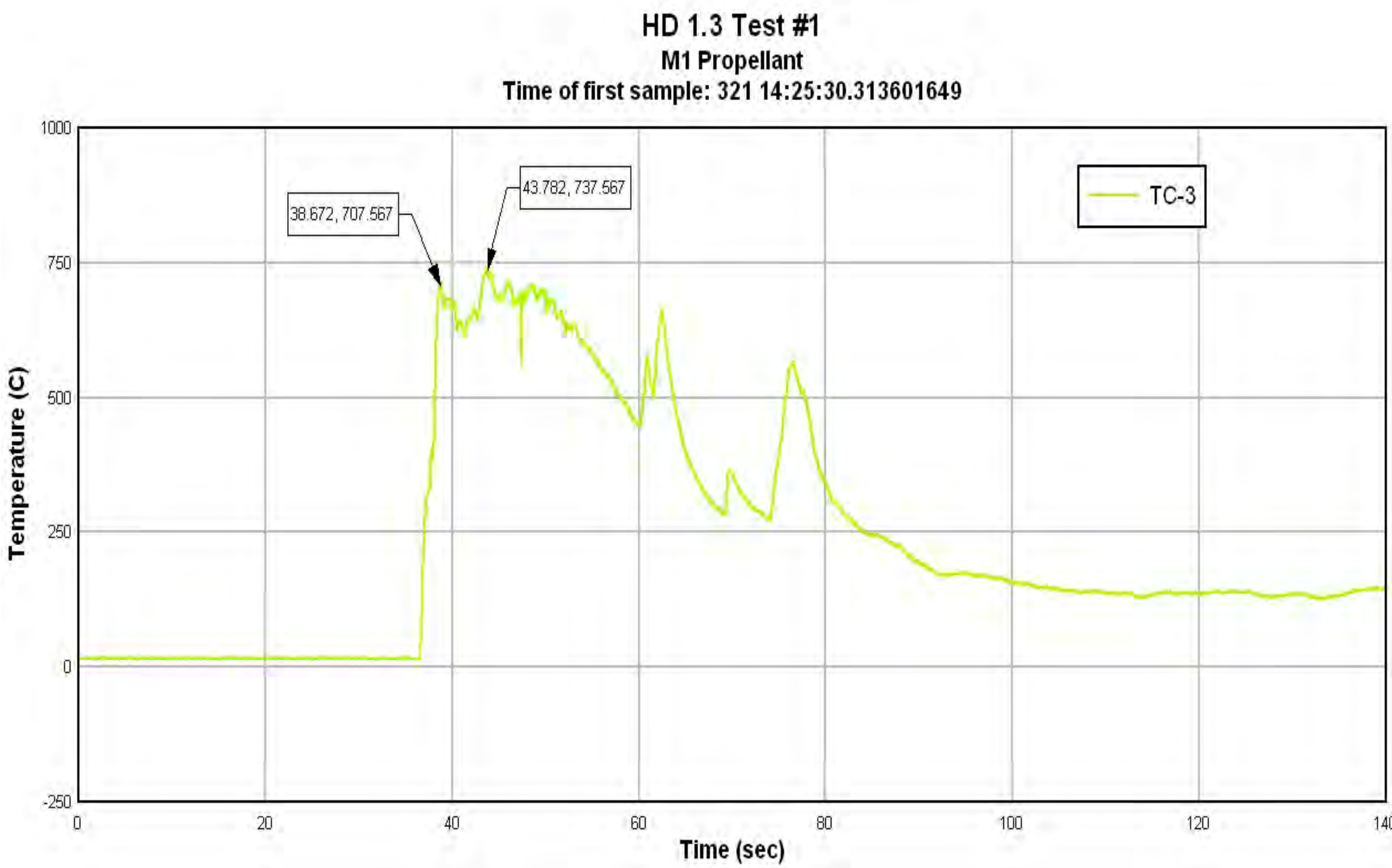

FIGURE II-B-3. Thermocouple #3.

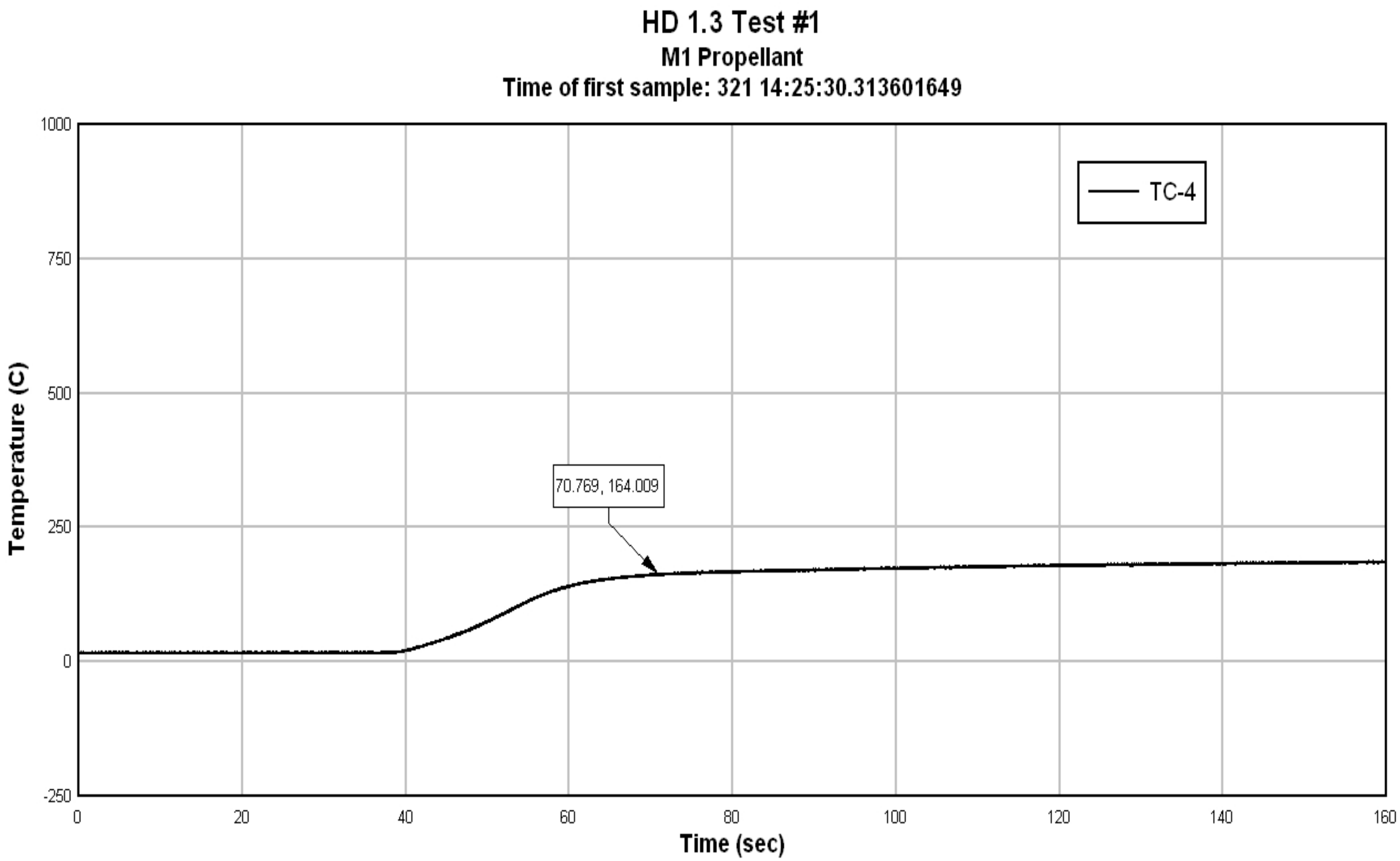

FIGURE II-B-4. Thermocouple #4.

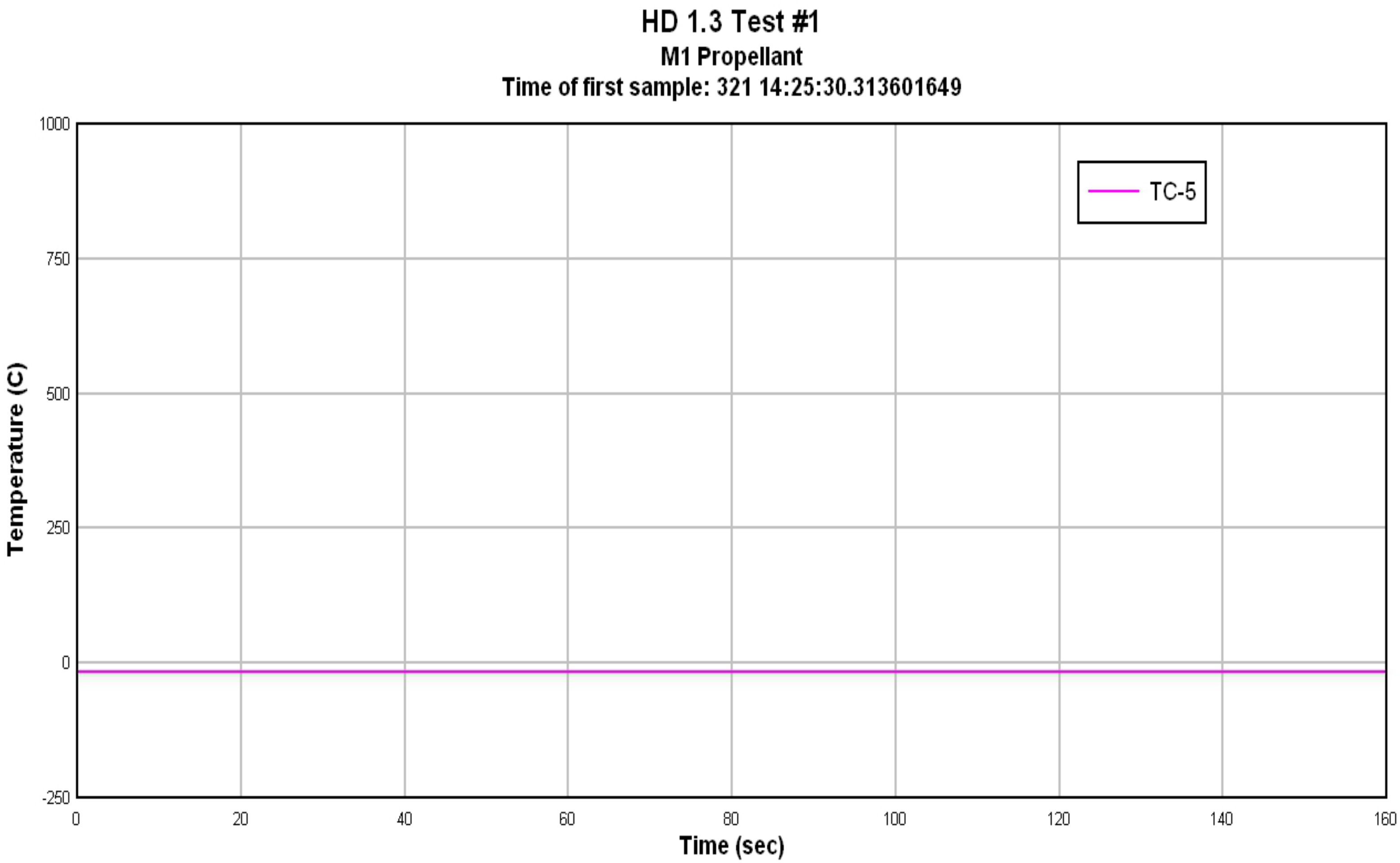

FIGURE II-B-5. Thermocouple #5.

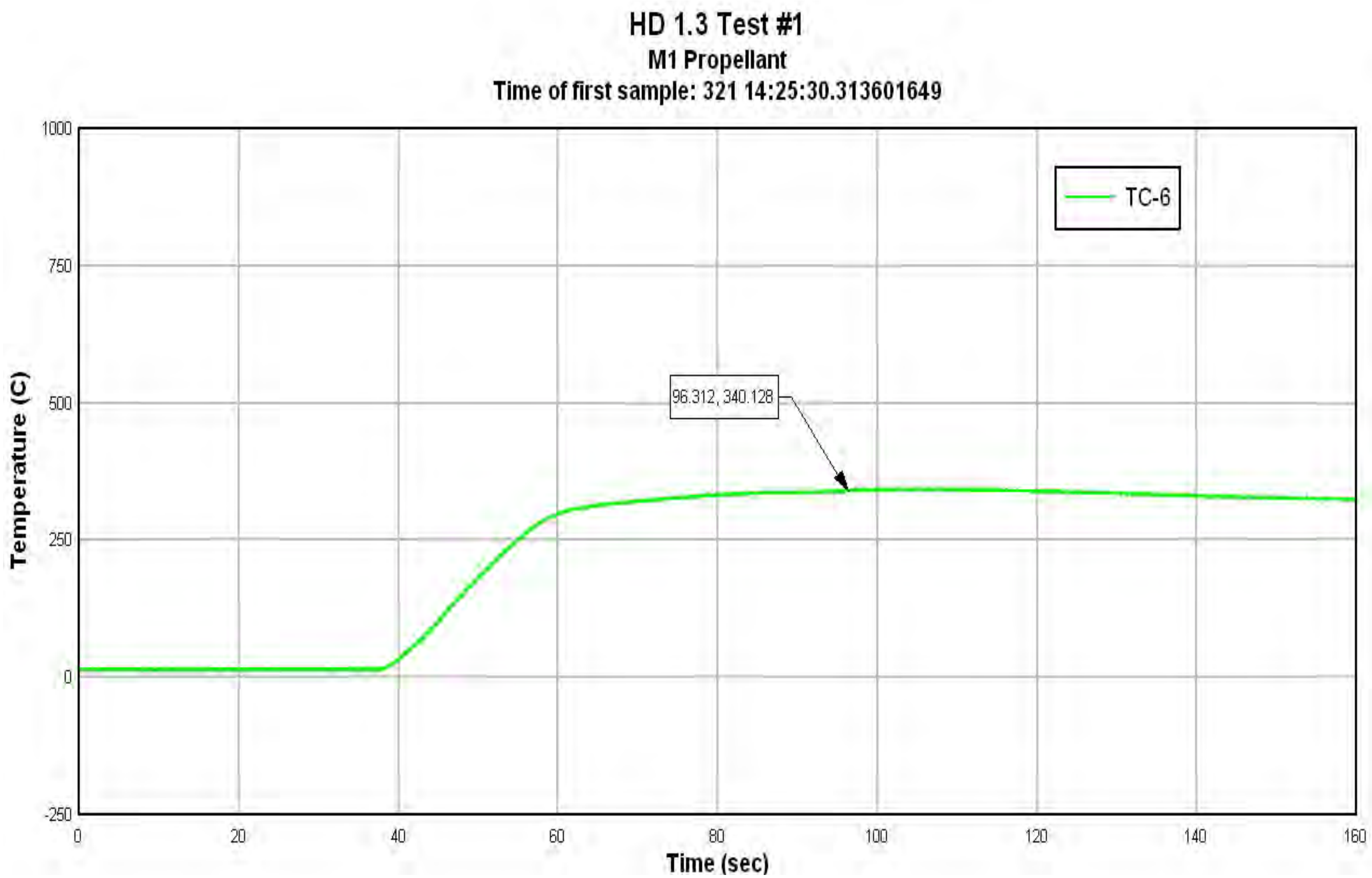

FIGURE II-B-6. Thermocouple #6.

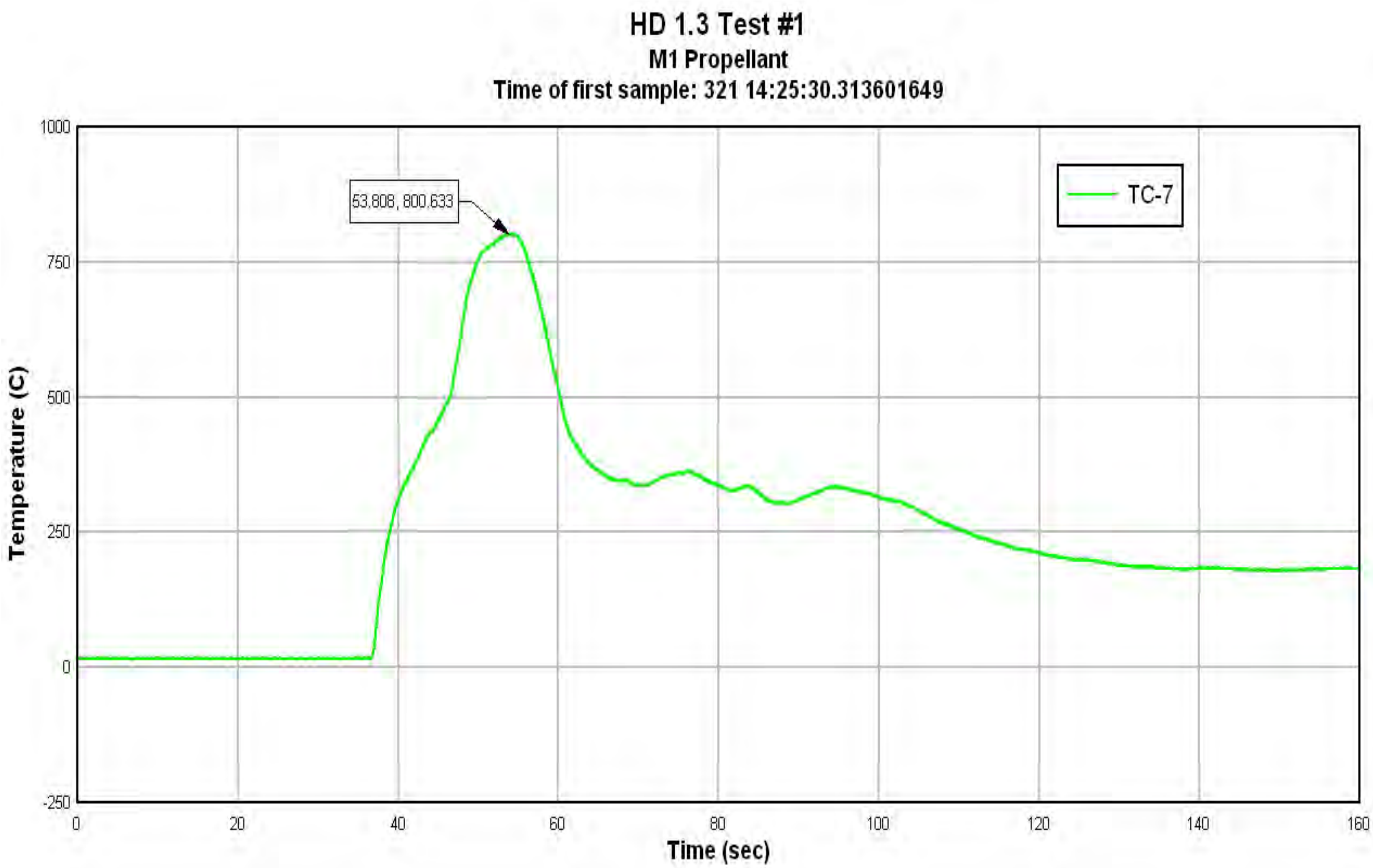

FIGURE II-B-7. Thermocouple #7.

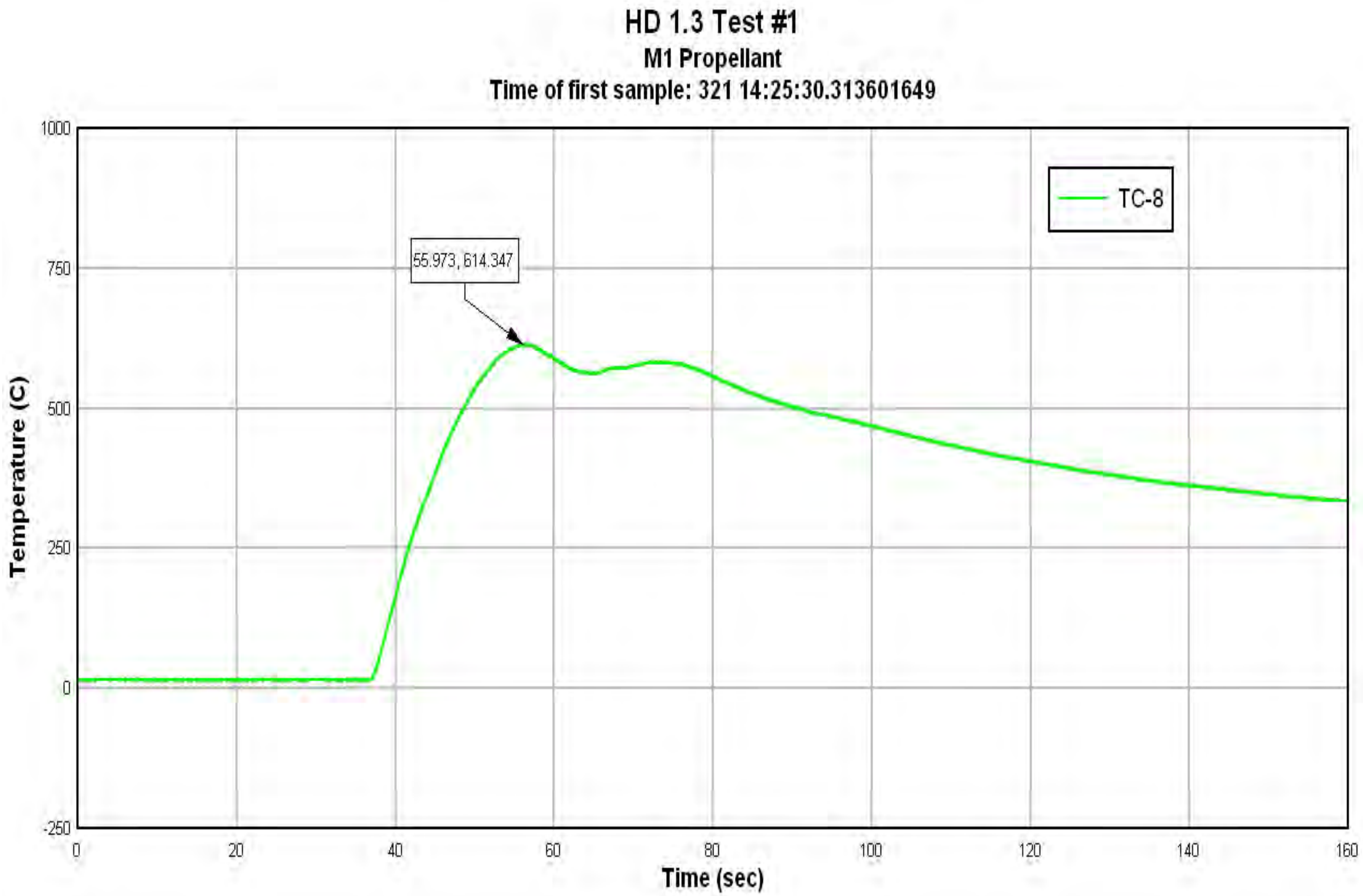

FIGURE II-B-8. Thermocouple #8.

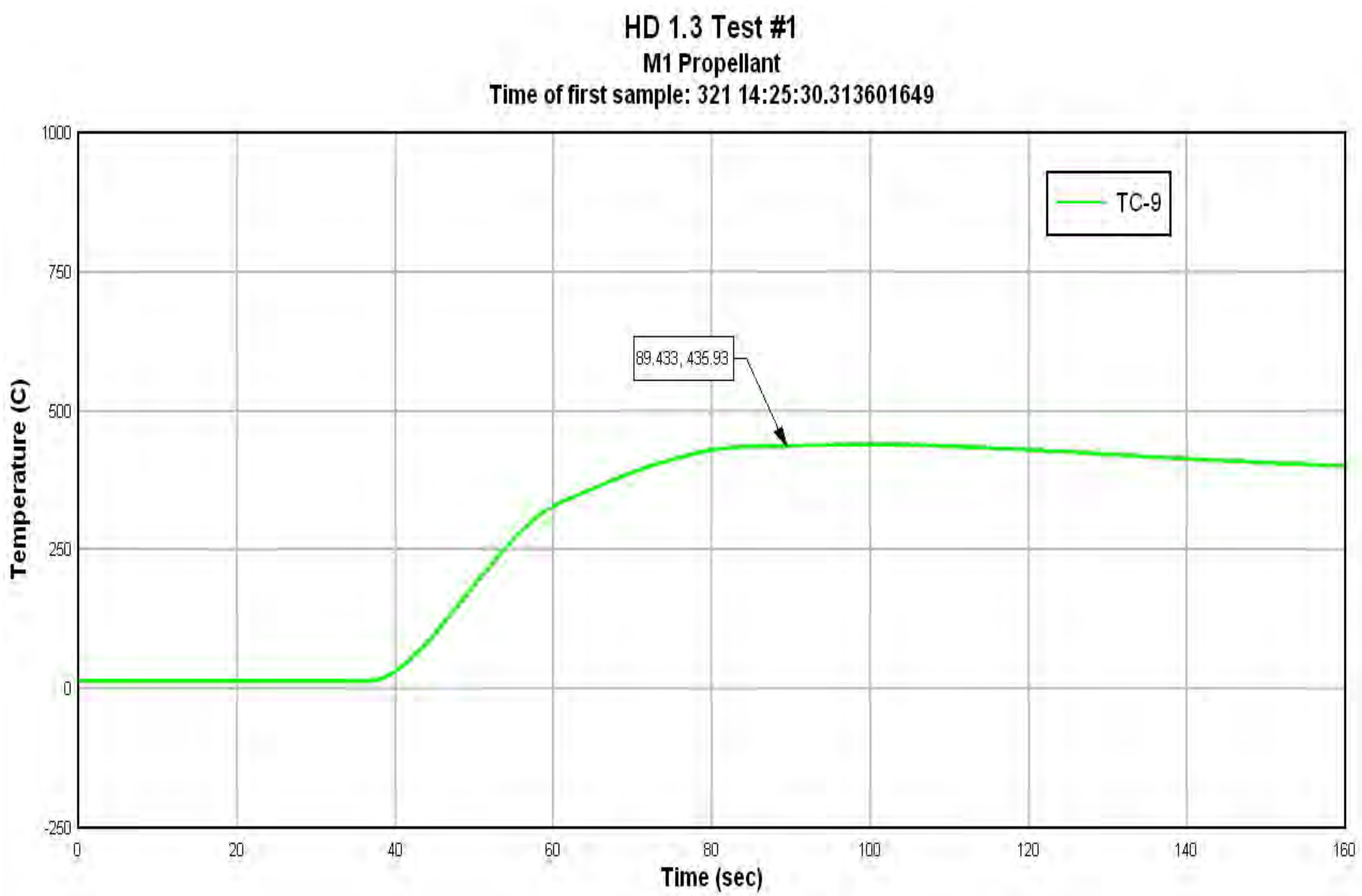

FIGURE II-B-9. Thermocouple #9.

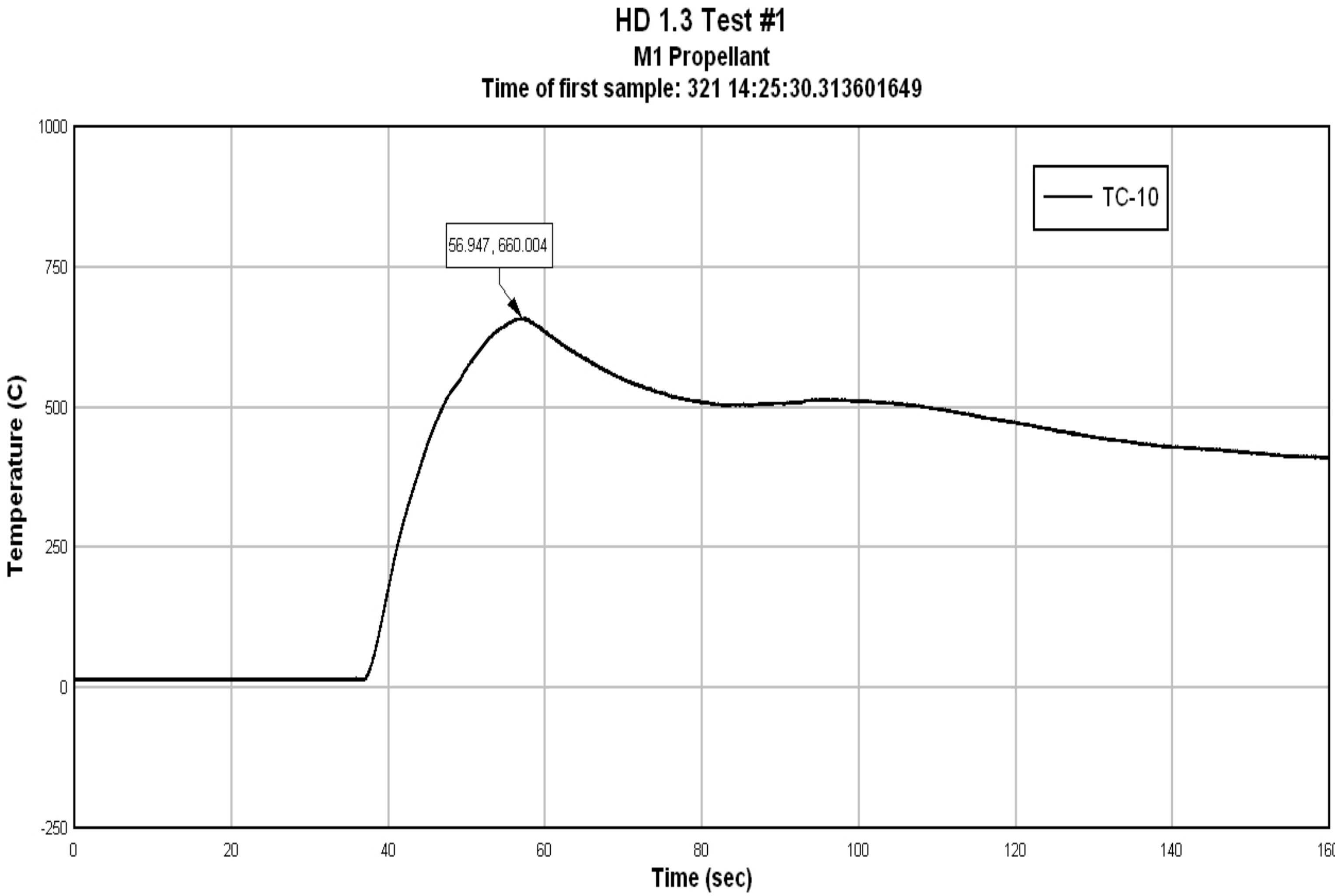

FIGURE II-B-10. Thermocouple #10.

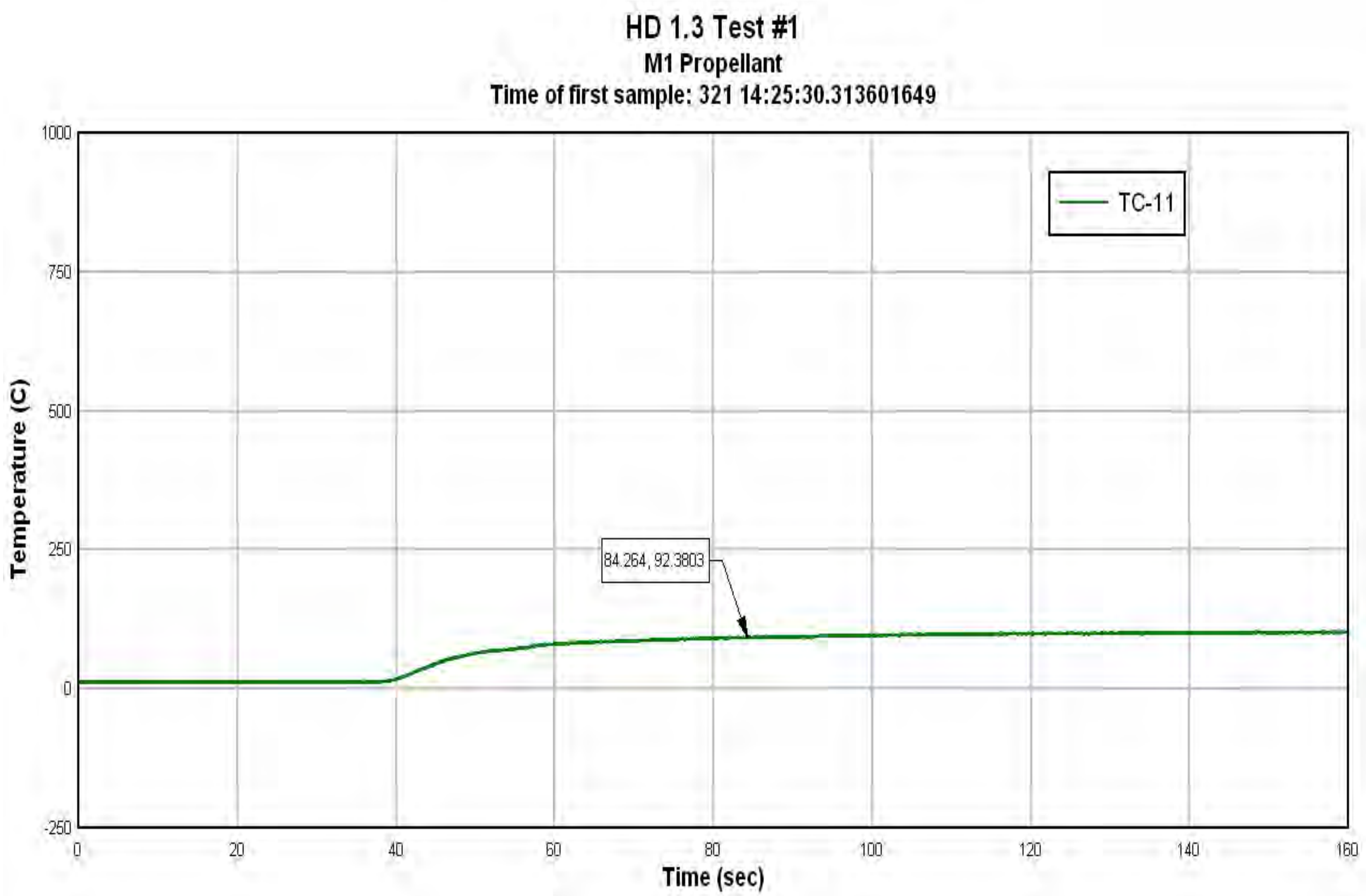

FIGURE II-B-11. Thermocouple #11.

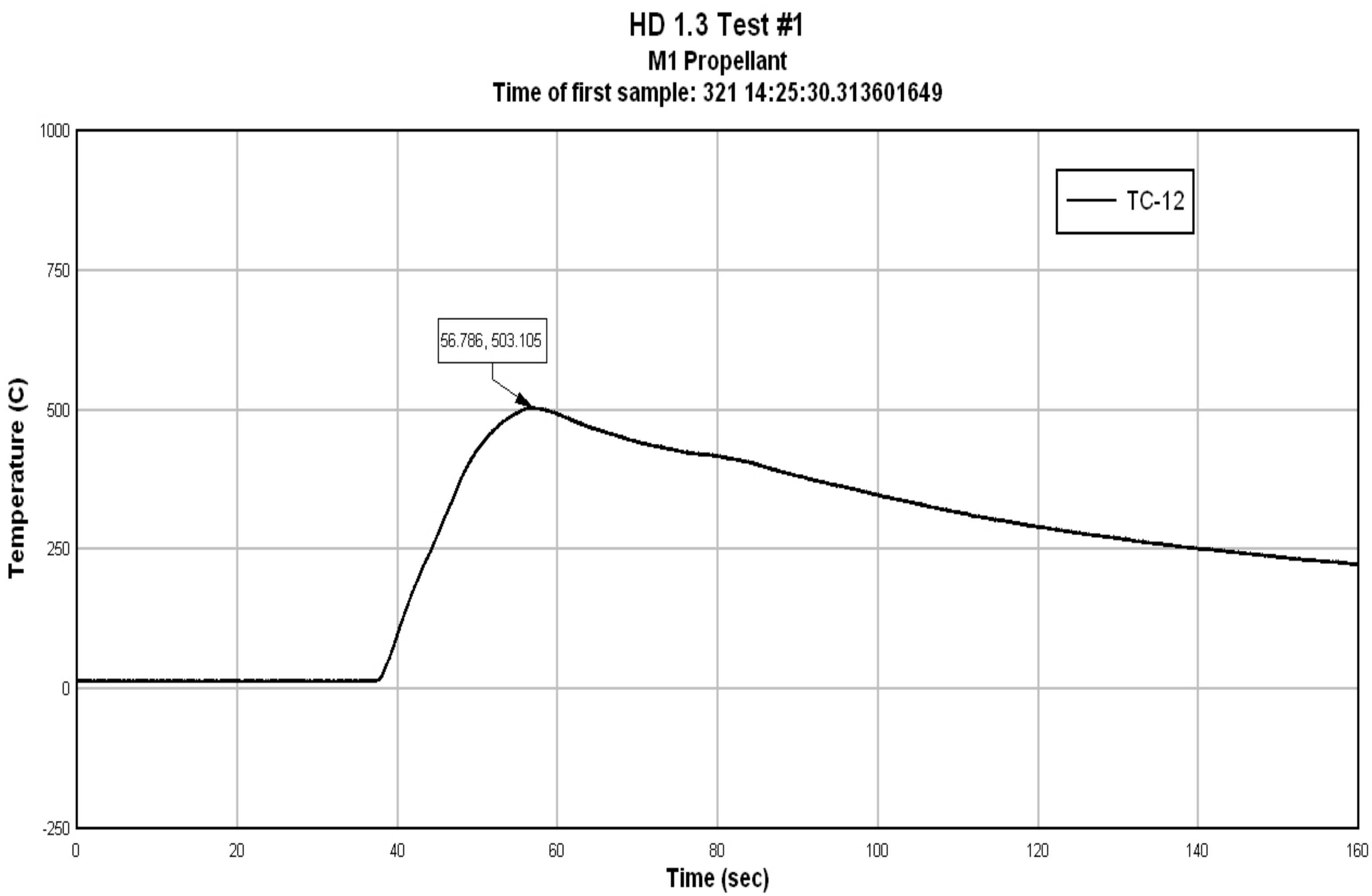

FIGURE II-B-12. Thermocouple #12.

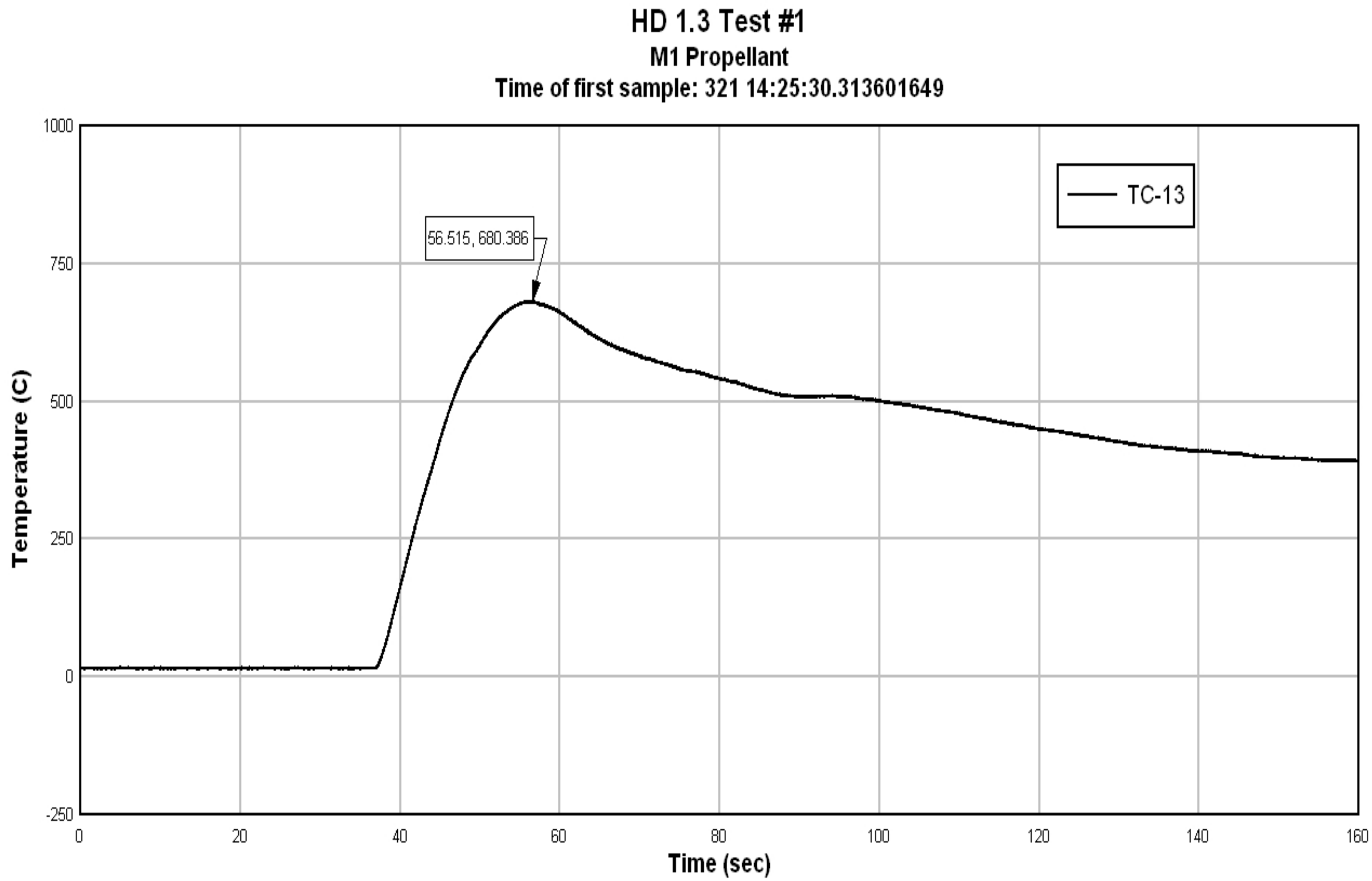

FIGURE II-B-13. Thermocouple #13.

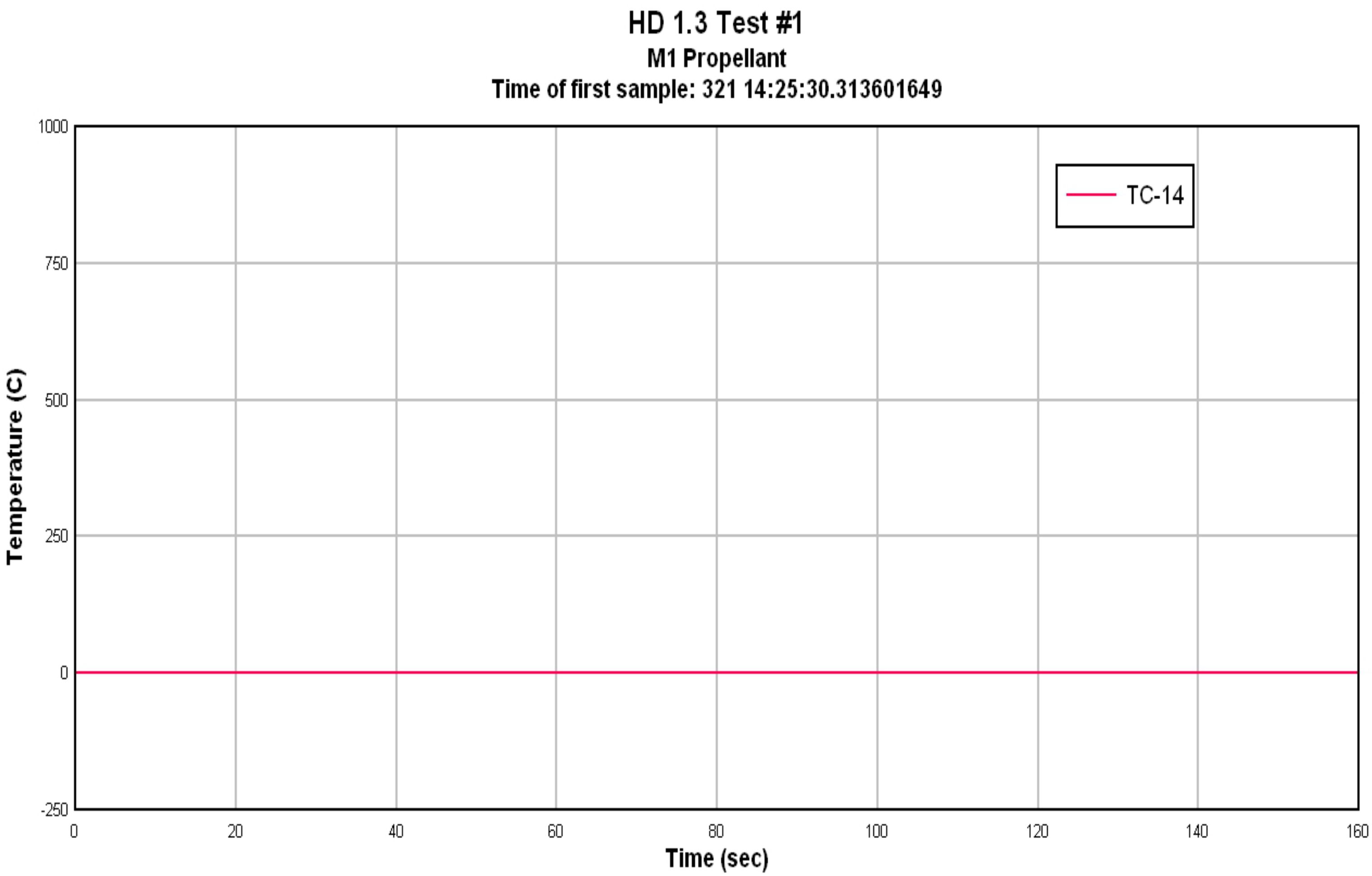

FIGURE II-B-14. Thermocouple #14.

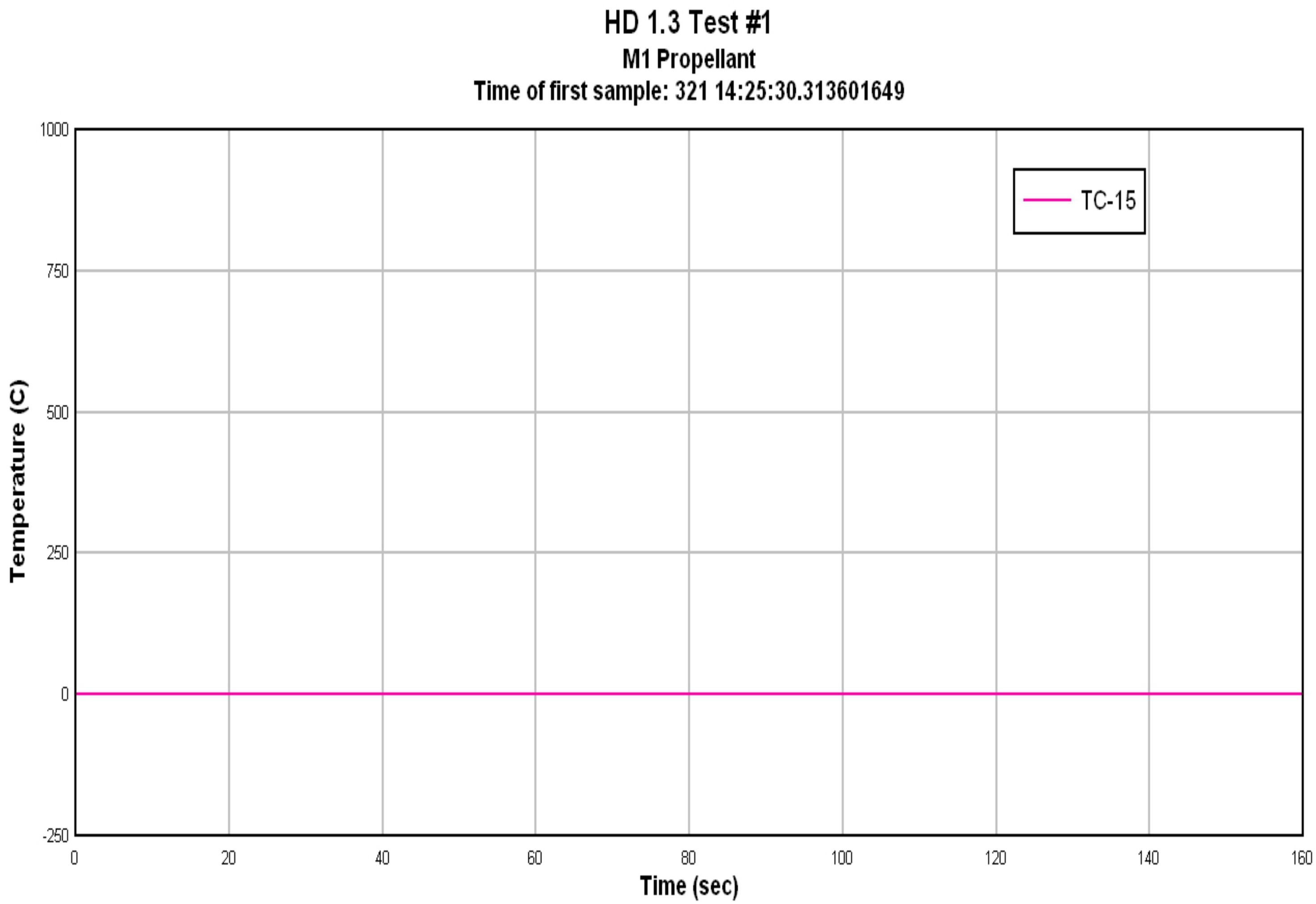

FIGURE II-B-15. Thermocouple #15.

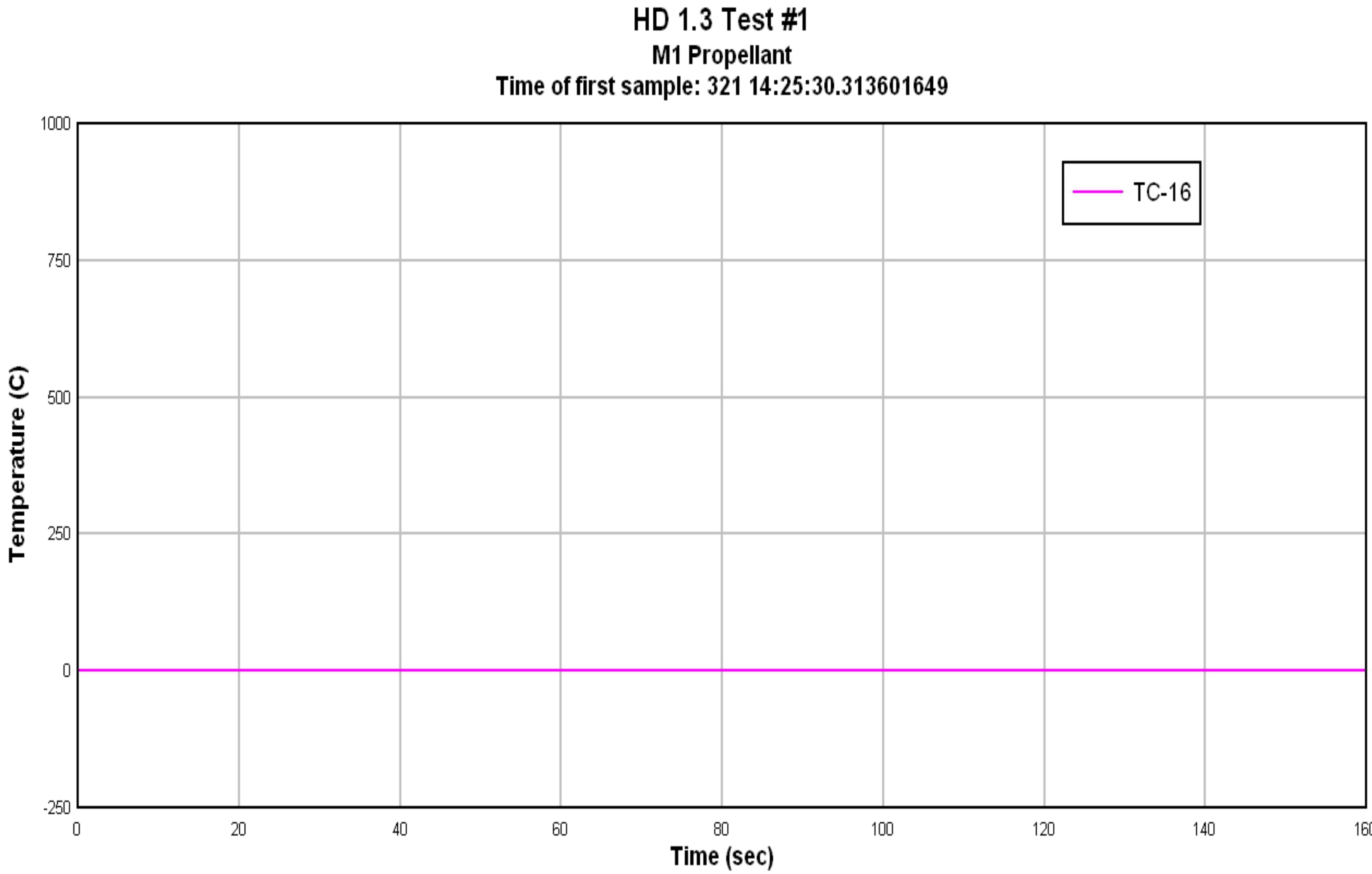

FIGURE II-B-16. Thermocouple #16.

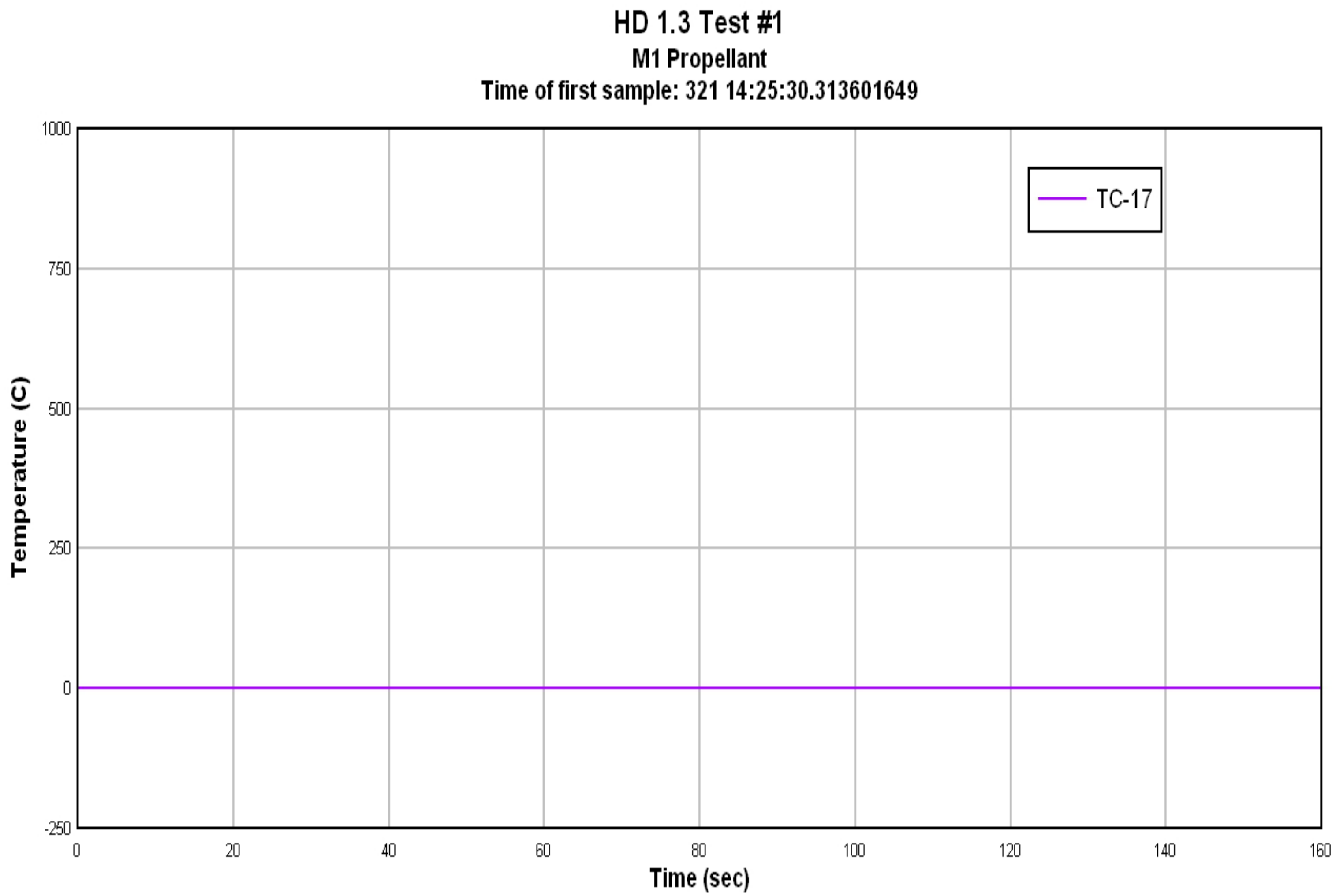

FIGURE II-B-17. Thermocouple #17.

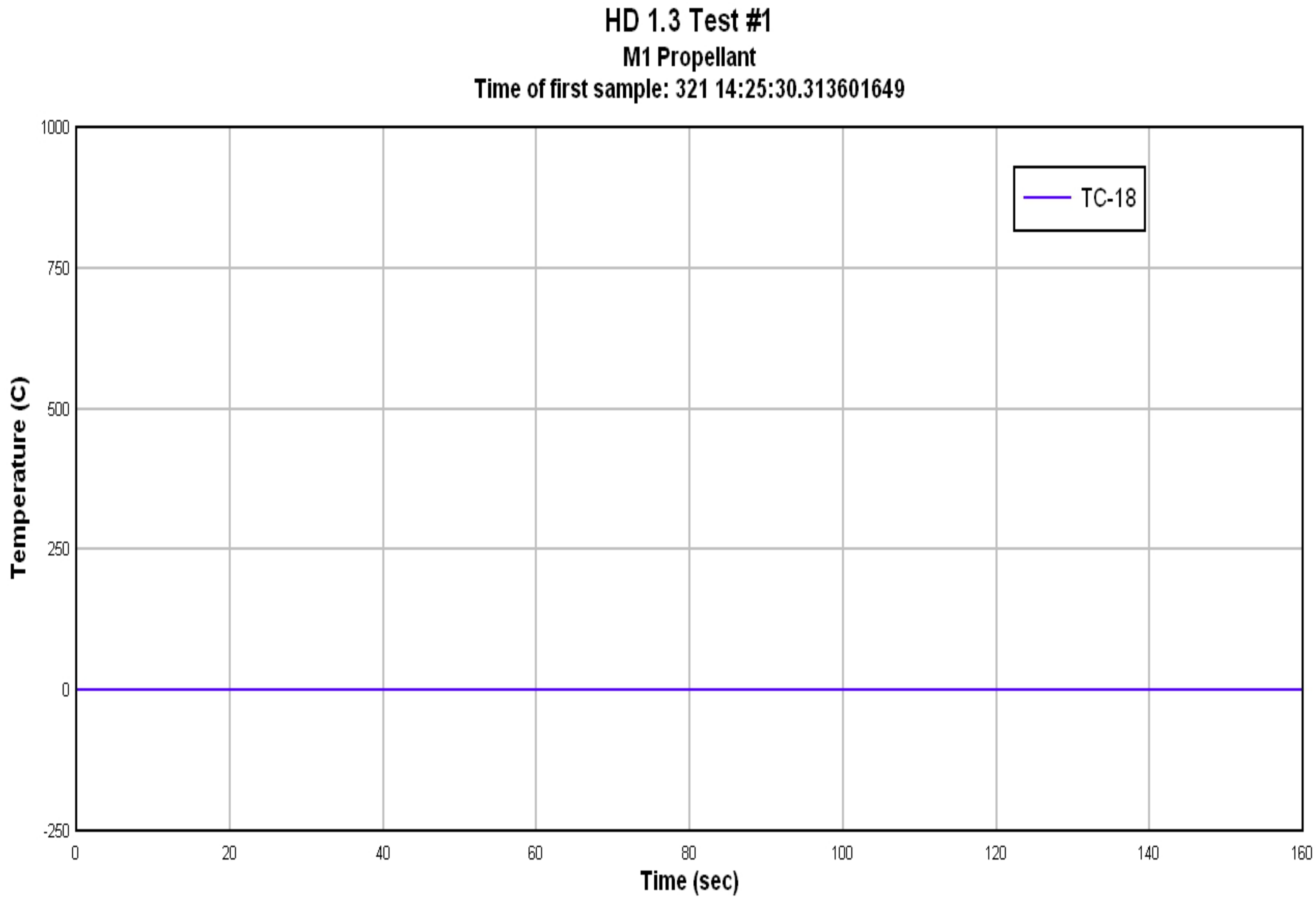

FIGURE II-B-18. Thermocouple #18.

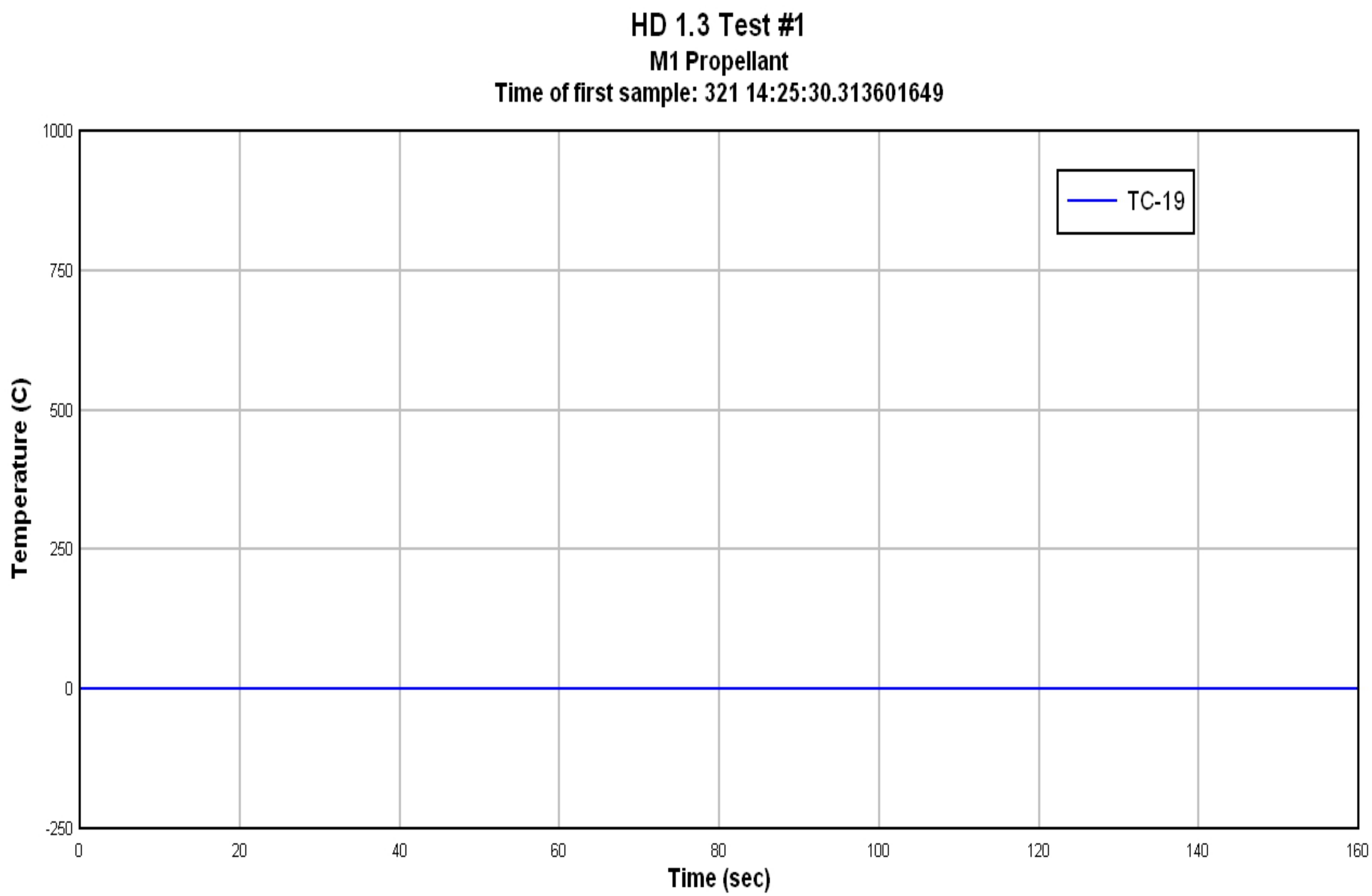

FIGURE II-B-19. Thermocouple #19.

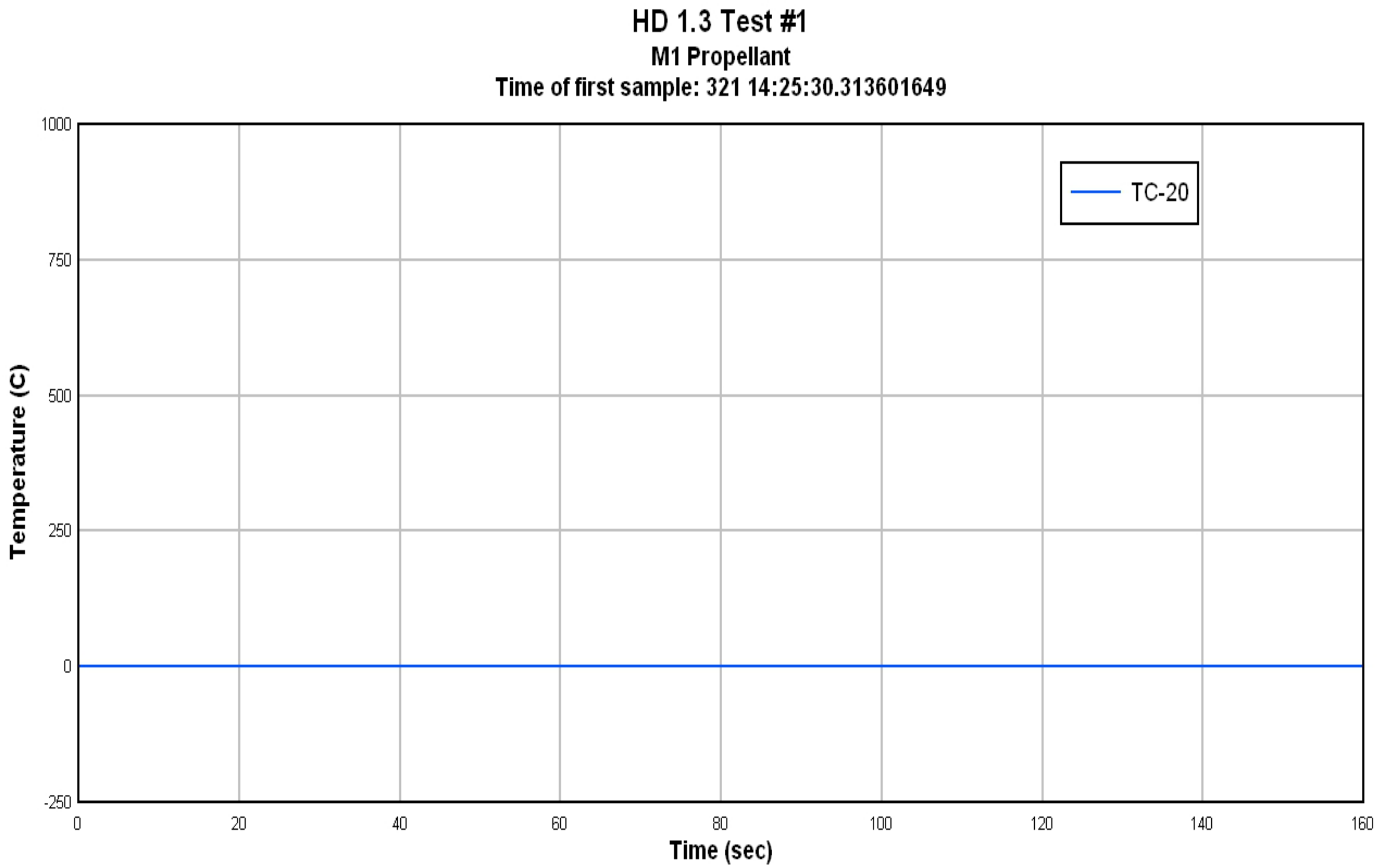

FIGURE II-B-20. Thermocouple #20.

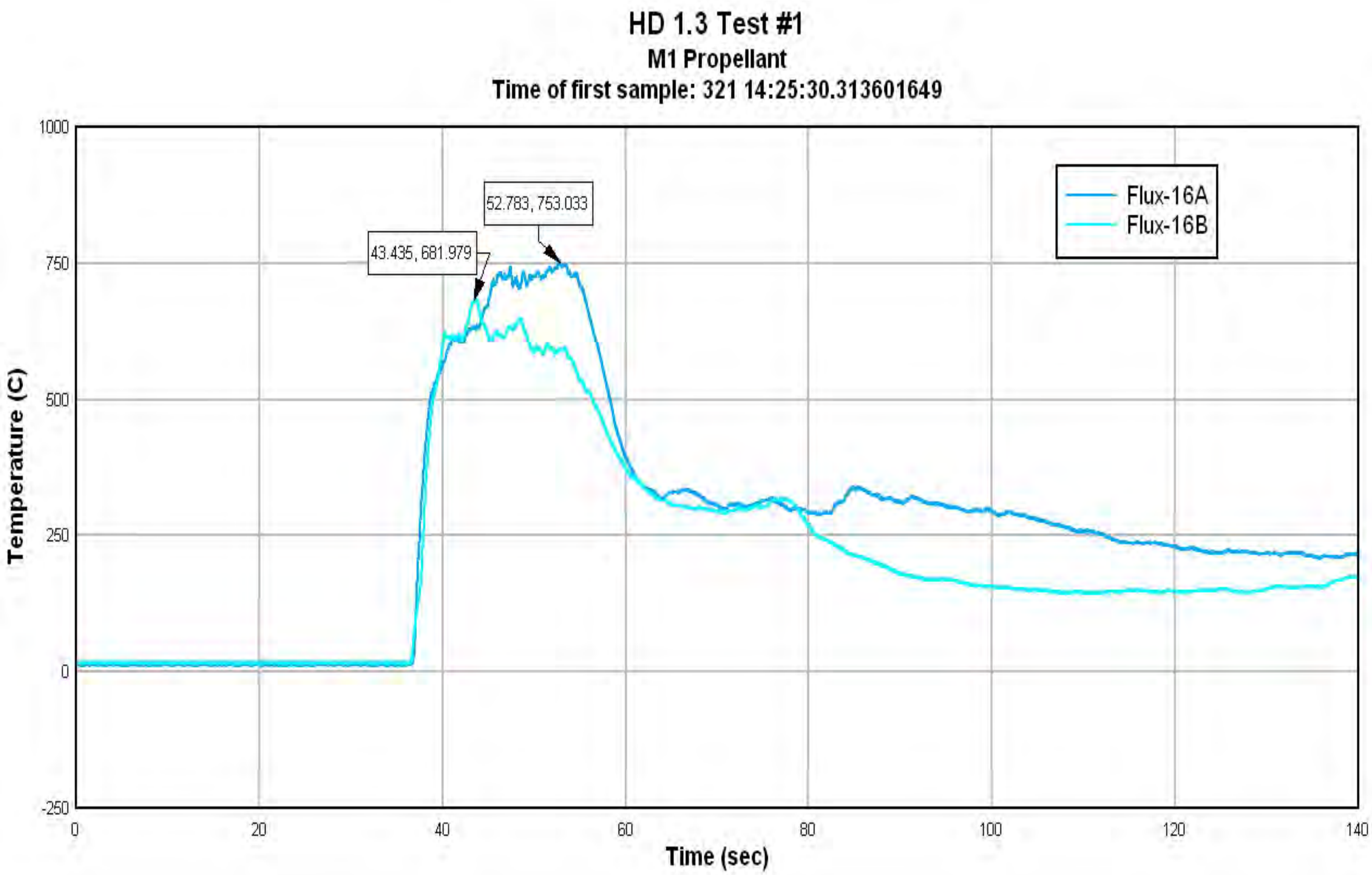

FIGURE II-B-21. Flux Gage #16A and 16B (Inside).

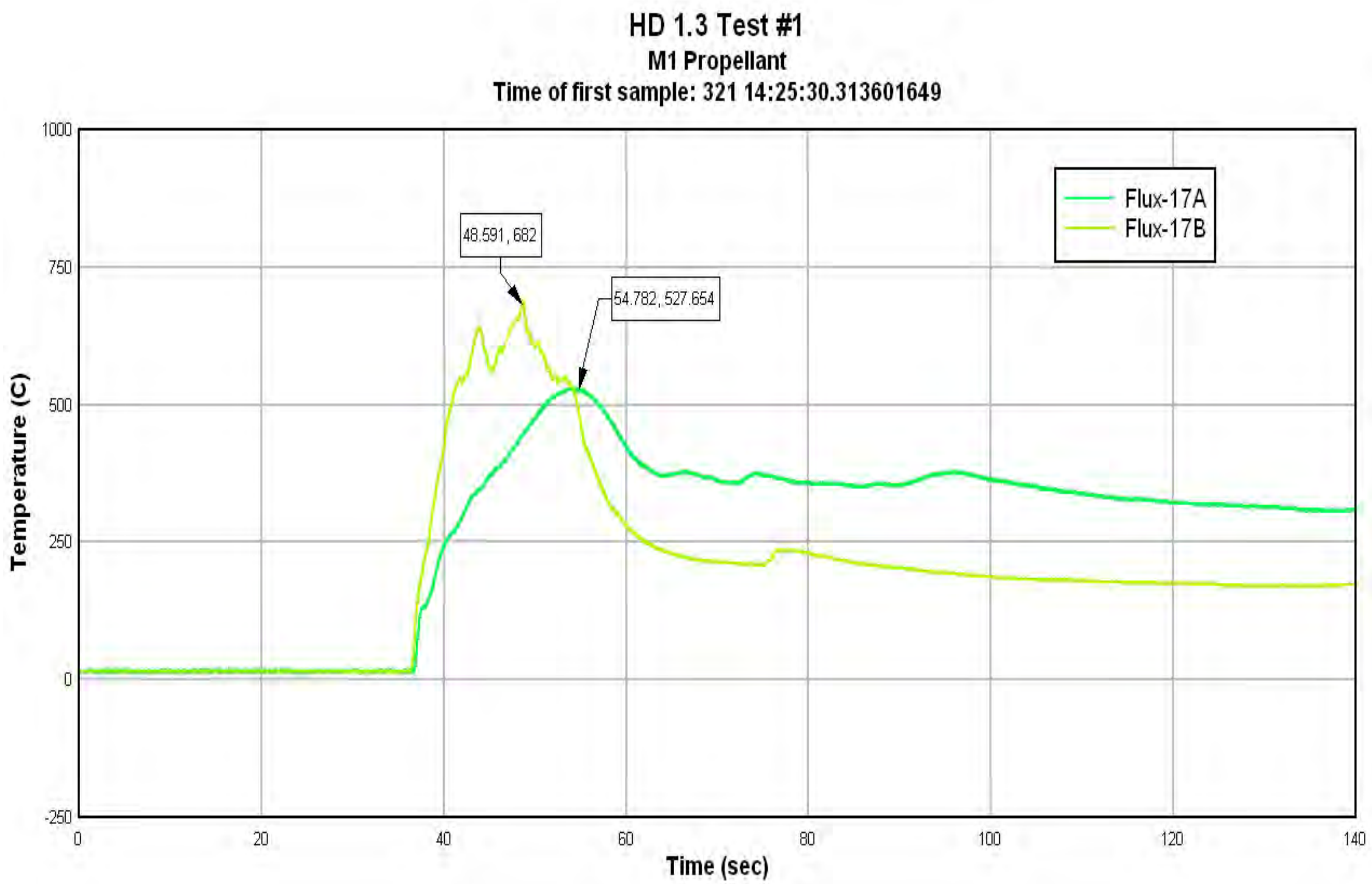

FIGURE II-B-22. Flux Gage #17A and 17B (Inside).

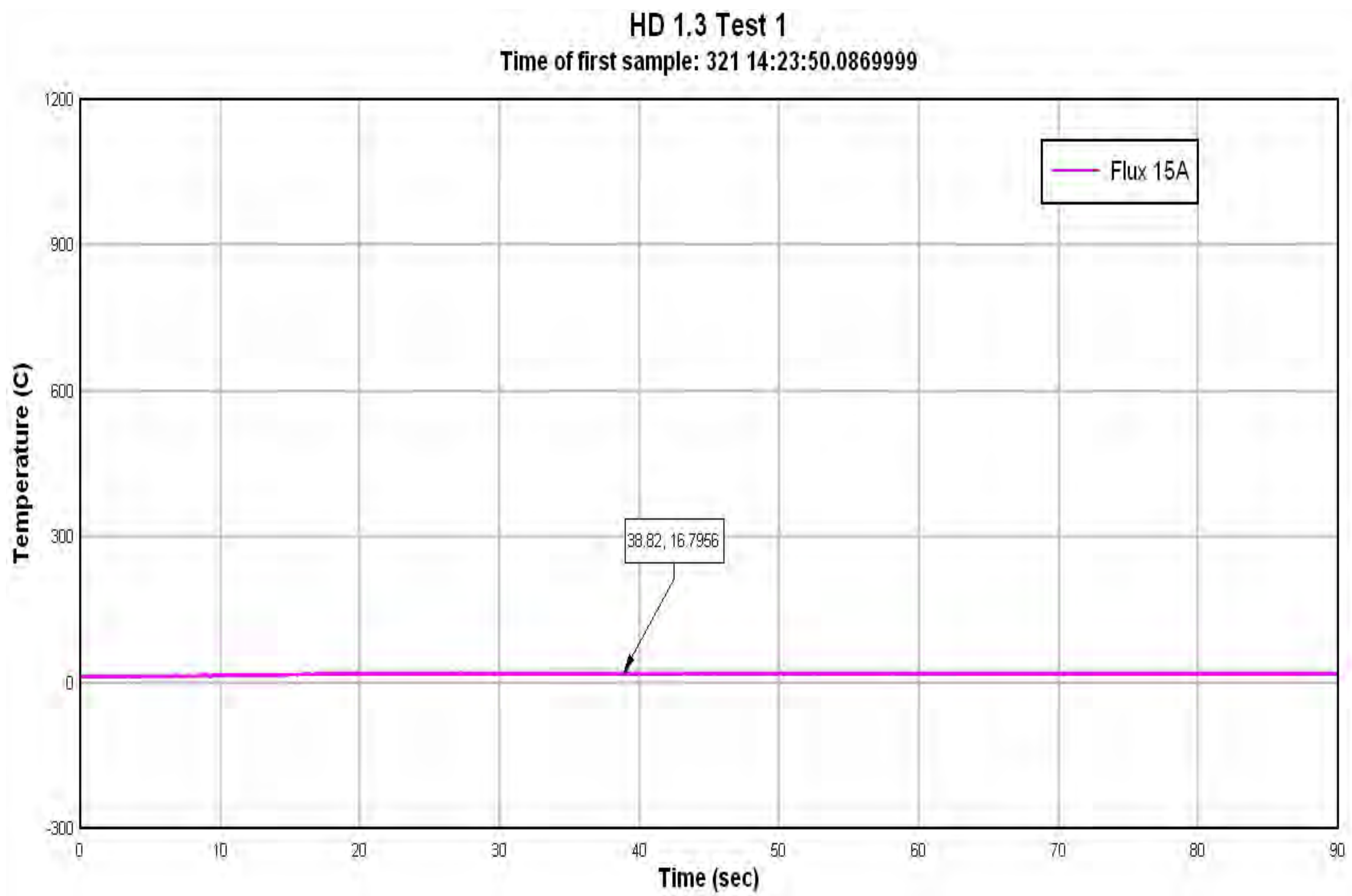

FIGURE II-B-23. Flux Gage #15A (Outside).

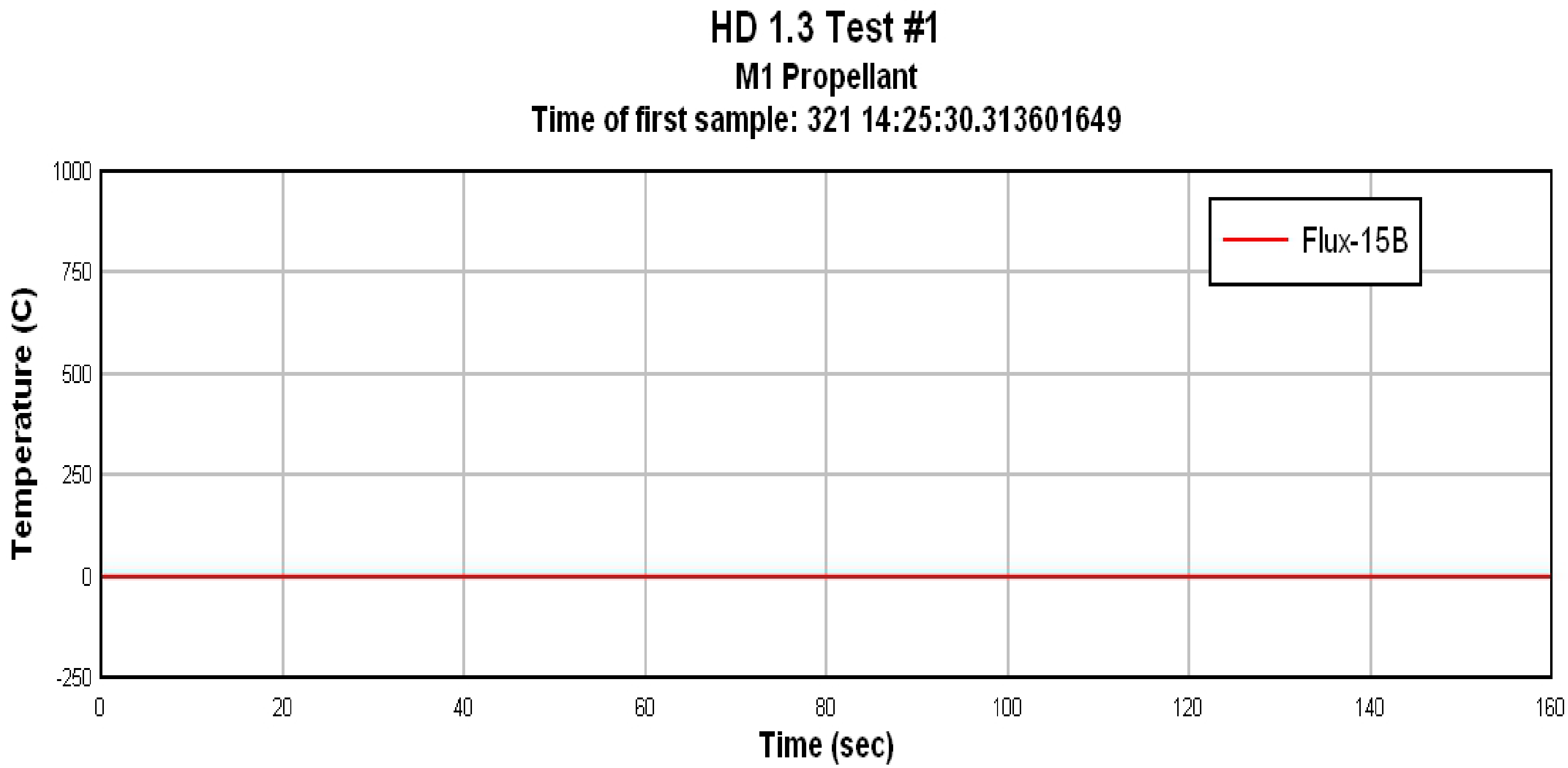

FIGURE II-B-24. Flux Gage #15B (Outside).

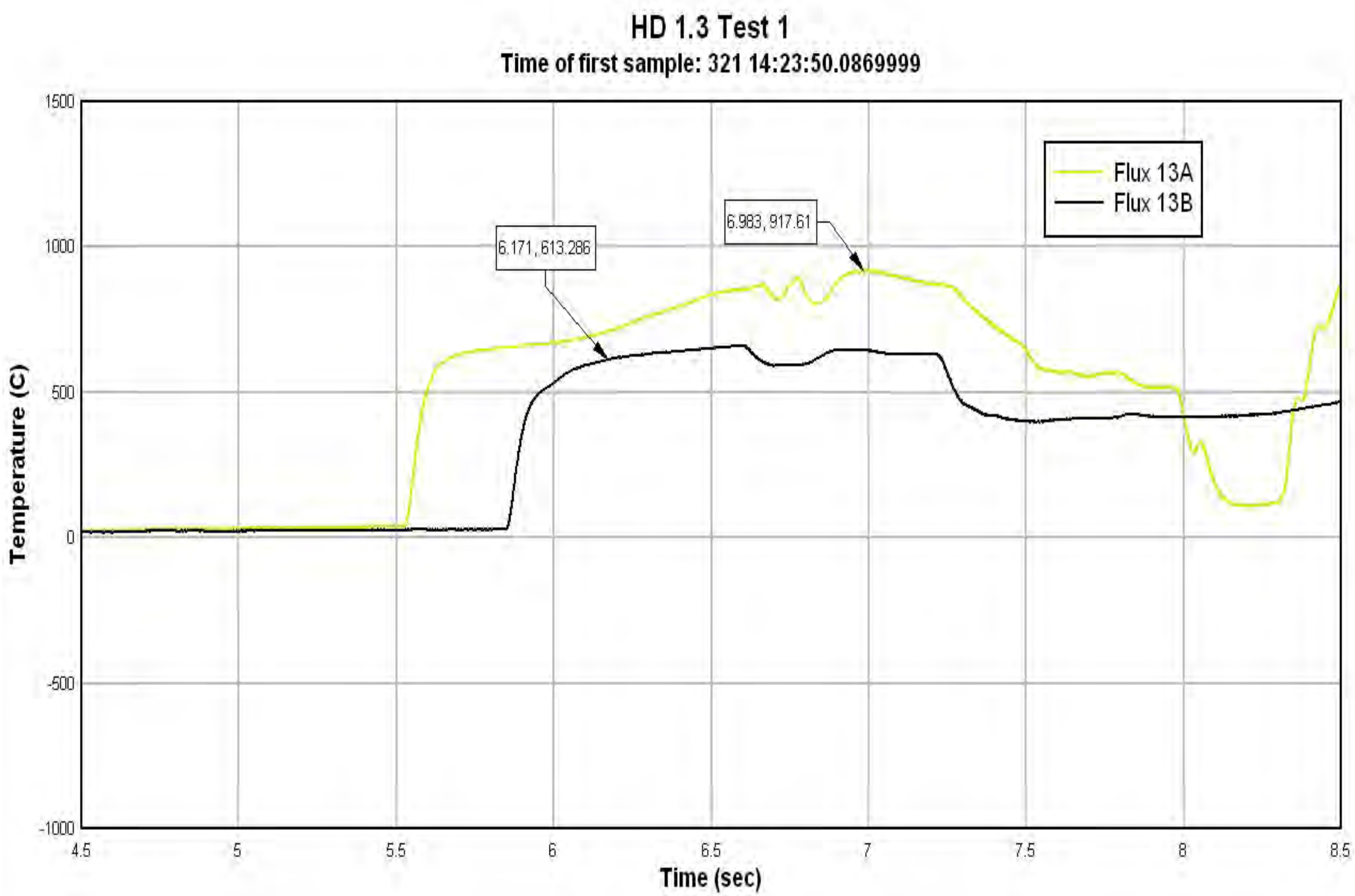

FIGURE II-B-25. Flux Gage #13A and 13B (Outside).

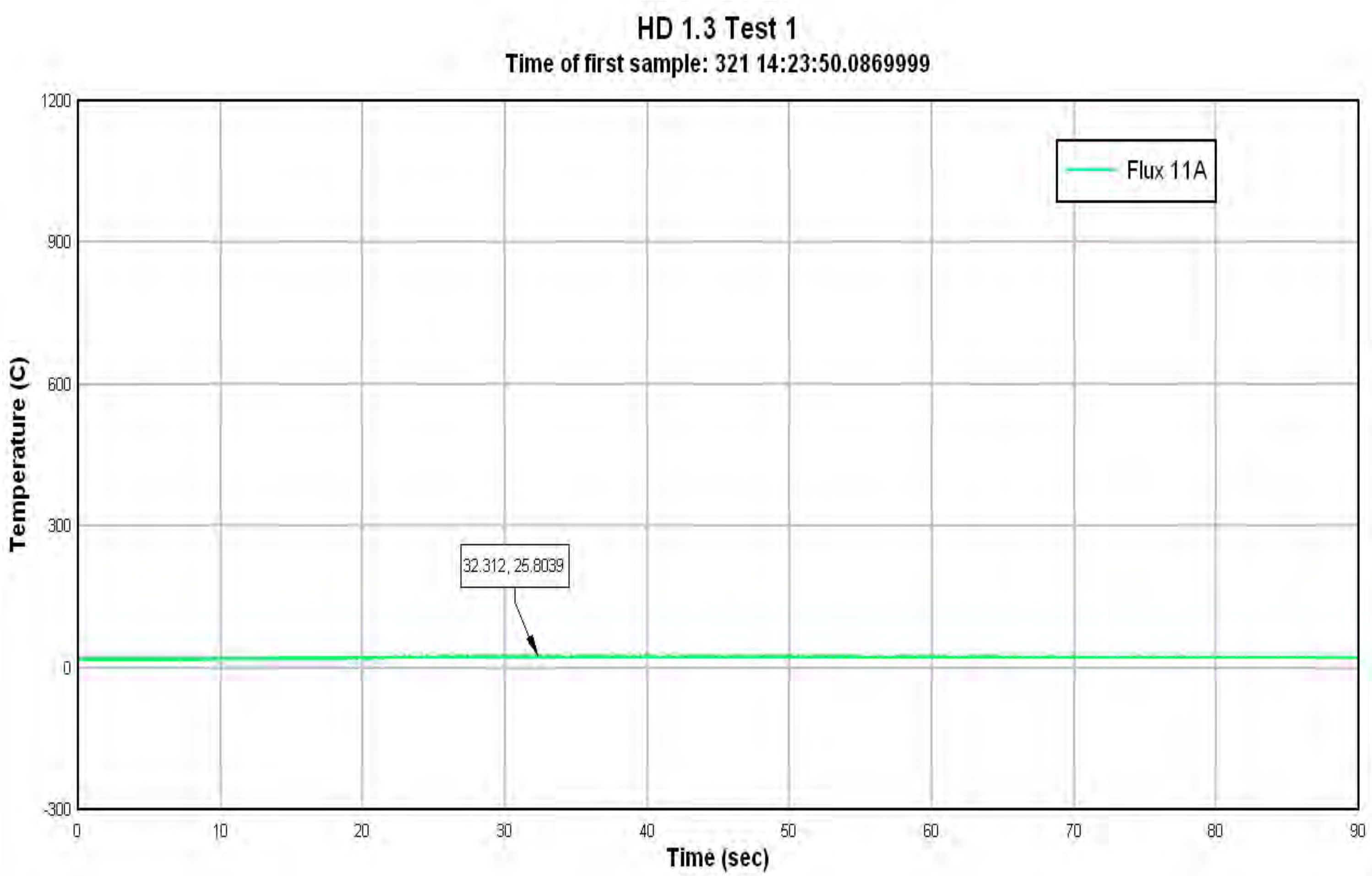

FIGURE II-B-26. Flux Gage #11A (Outside).

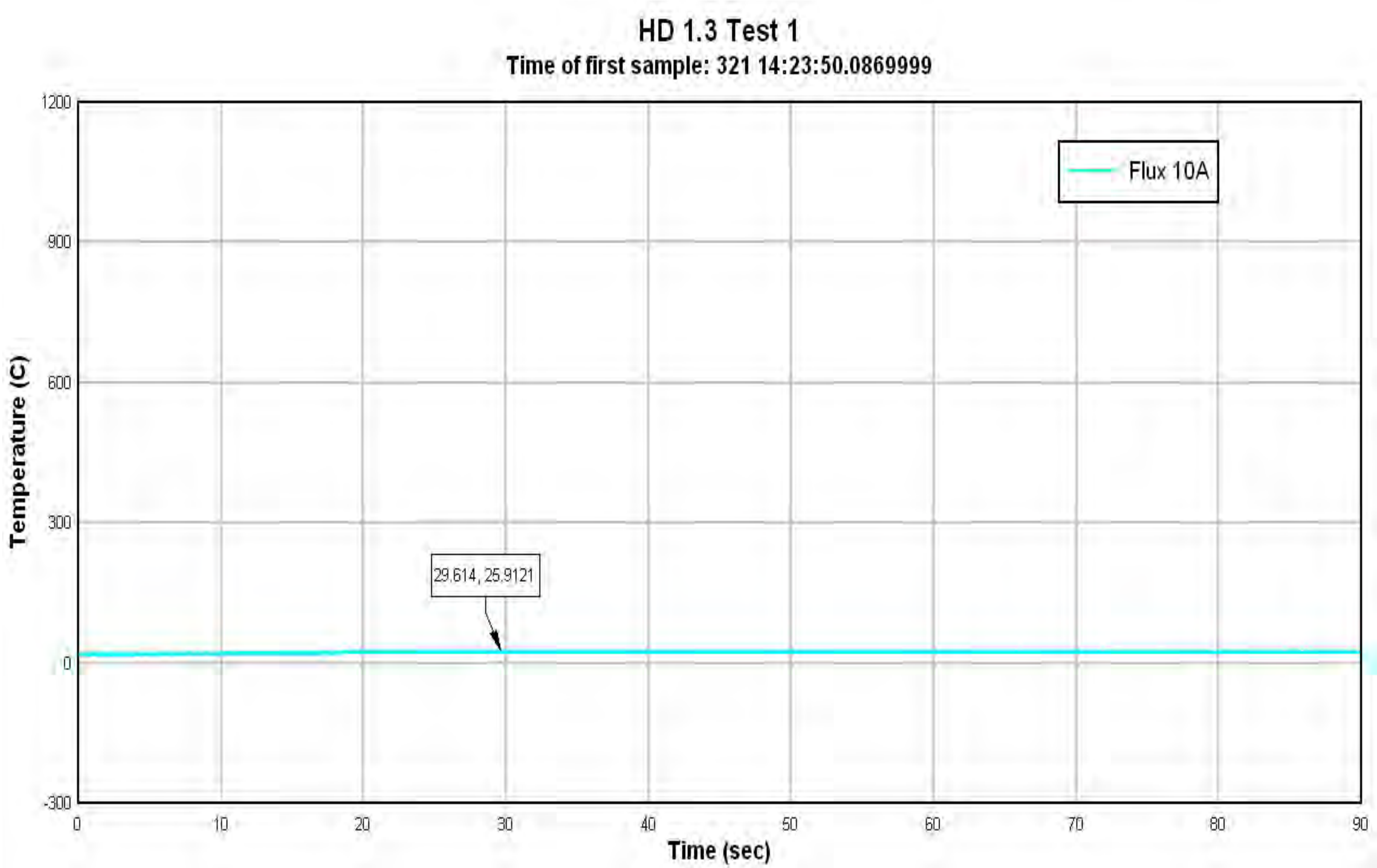

FIGURE II-B-27. Flux Gage #10A (Outside).

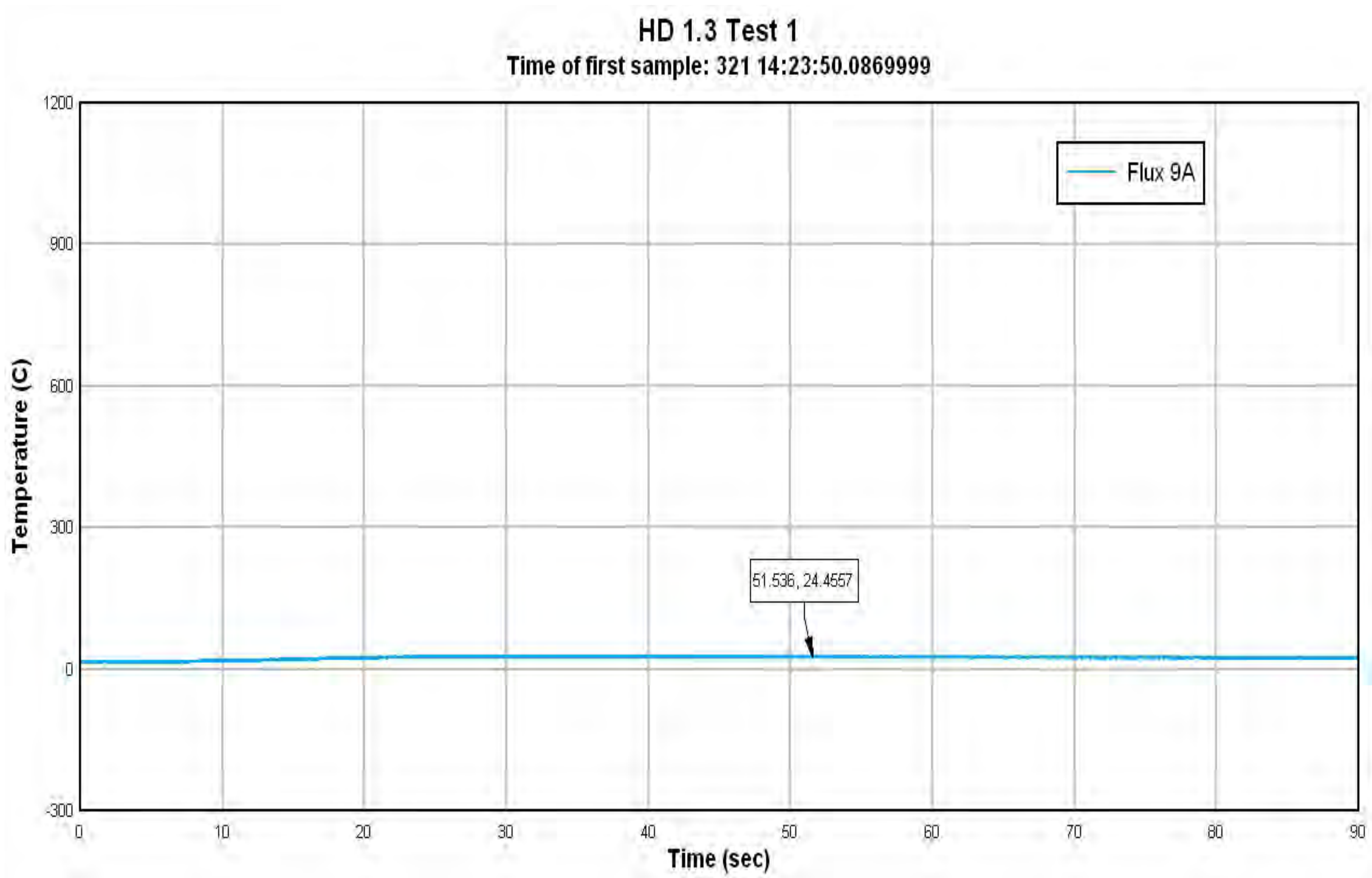

FIGURE II-B-28. Flux Gage #9A (Outside).

Summary

- Peak Temperatures Inside Structure
  - Thermocouple # 7 – 800.633C at 53.808 sec
  - 753.033C at 52.783 sec Flux Gage 16A
- Peak Temperatures Outside Structure
  - 917.61C at 6.963sec Flux Gage 13A

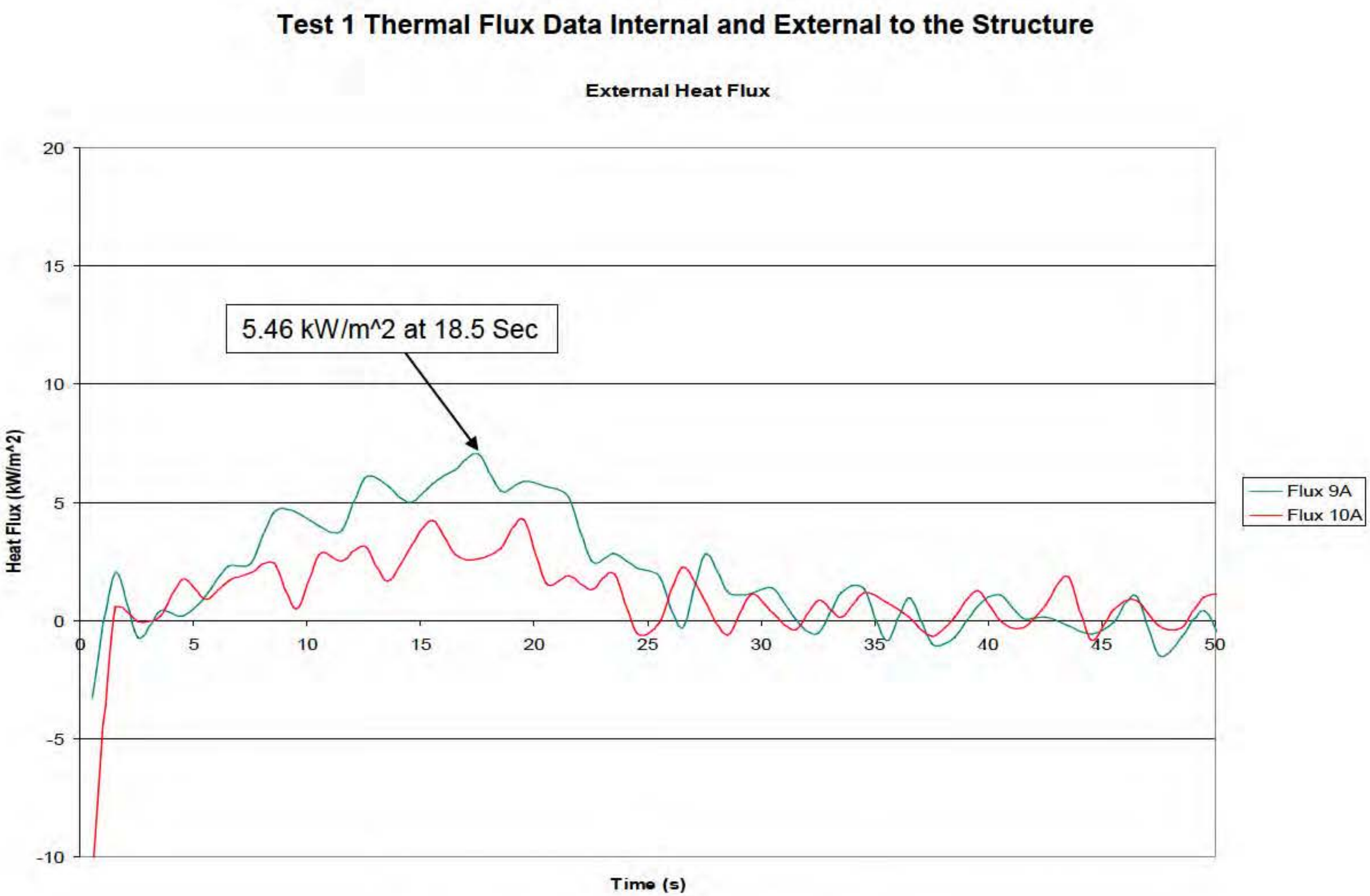

FIGURE II-B-29. Heat Flux Gages #9A and 10A.

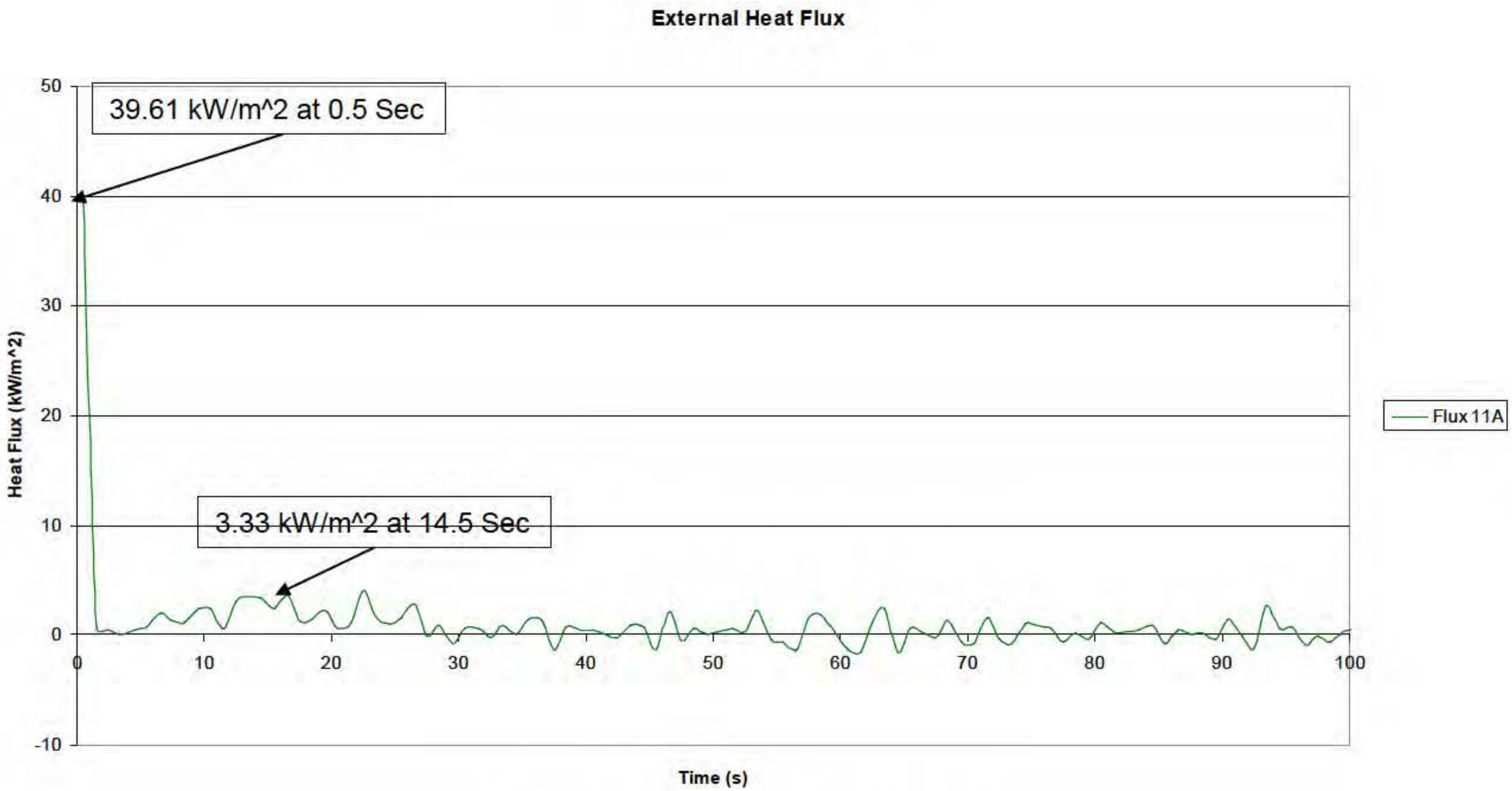

FIGURE II-B-30. Heat Flux Gages #11A.

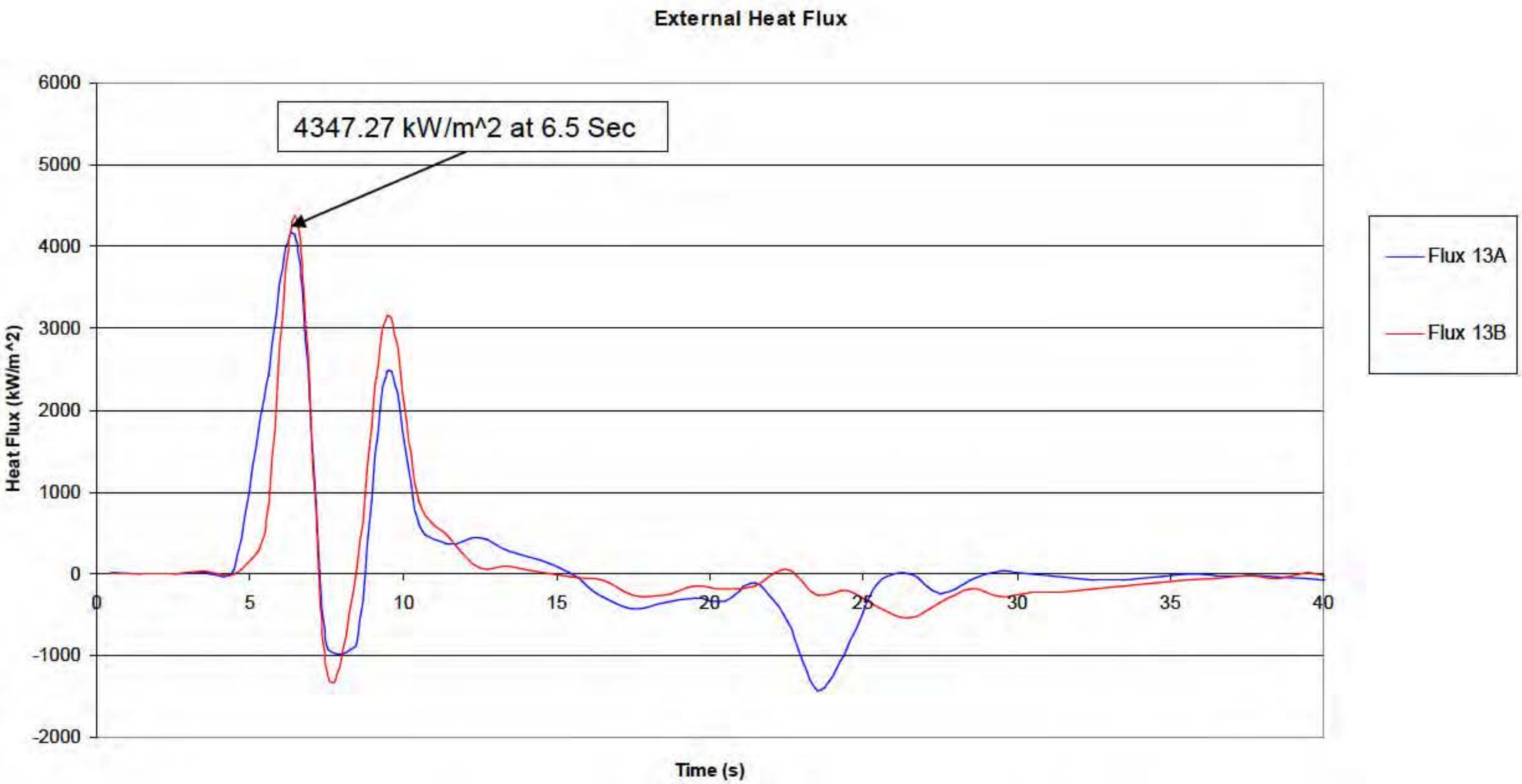

FIGURE II-B-31. Heat Flux Gages #13A and 13B.

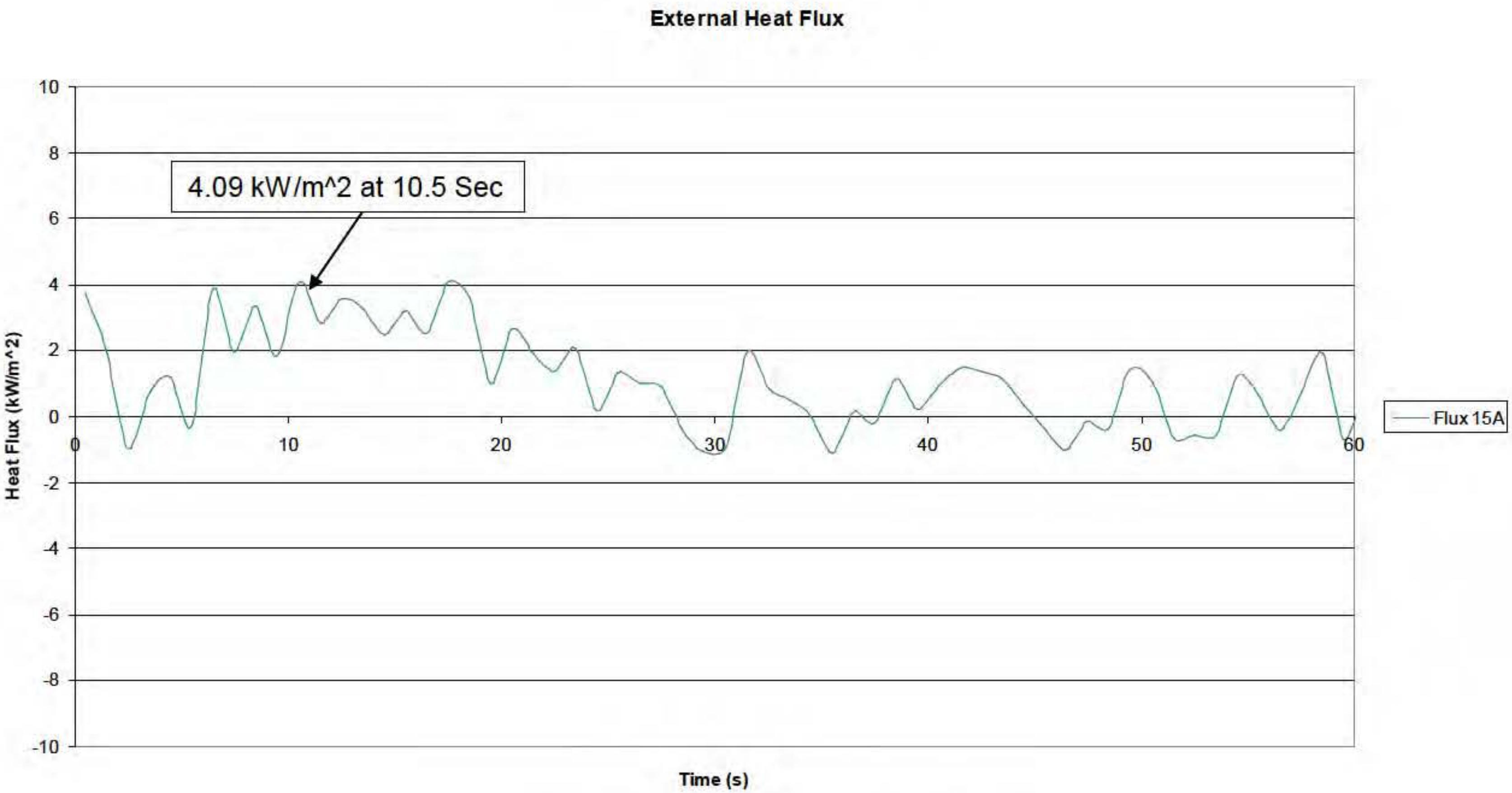

FIGURE II-B-32. Heat Flux Gages #15A.

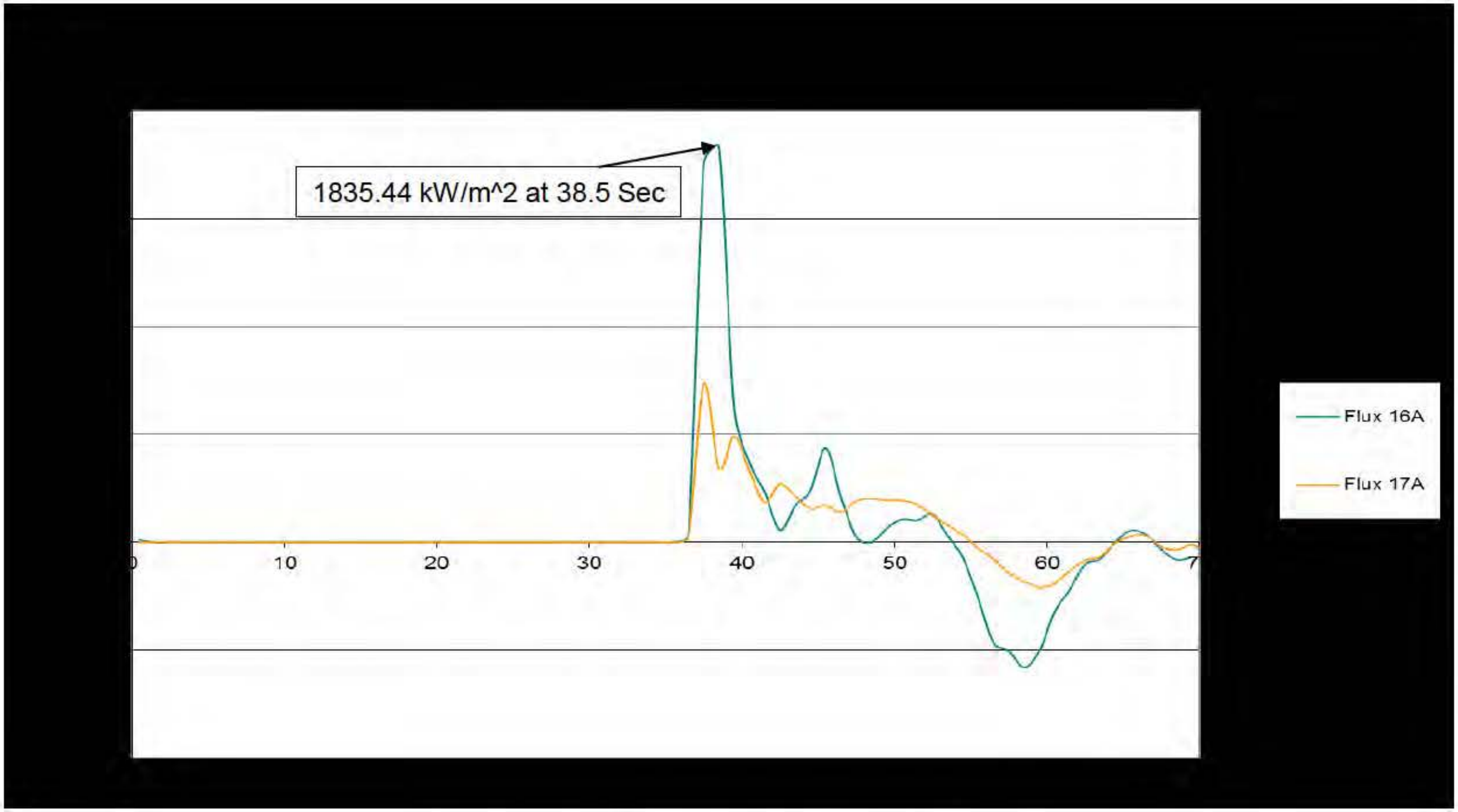

FIGURE II-B-33. Internal Flux Gages #16A and 17A.

Summary

- Peak Flux Inside Structure
  - DFT #16 – 1835.44 kW/m^2 at 38.5 sec
- Peak Flux Outside Structure
  - DFT #13 - 4,347kW/m^2 at 6.5sec

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Appendix II-C

HD1.3 TEST 1. HIGH-SPEED CAMERA FOOTAGE

(This appendix is included on the DVD.)

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Appendix II-D

HD1.3 TEST 1. DOPPLER DATA

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Test 1 Doppler Data

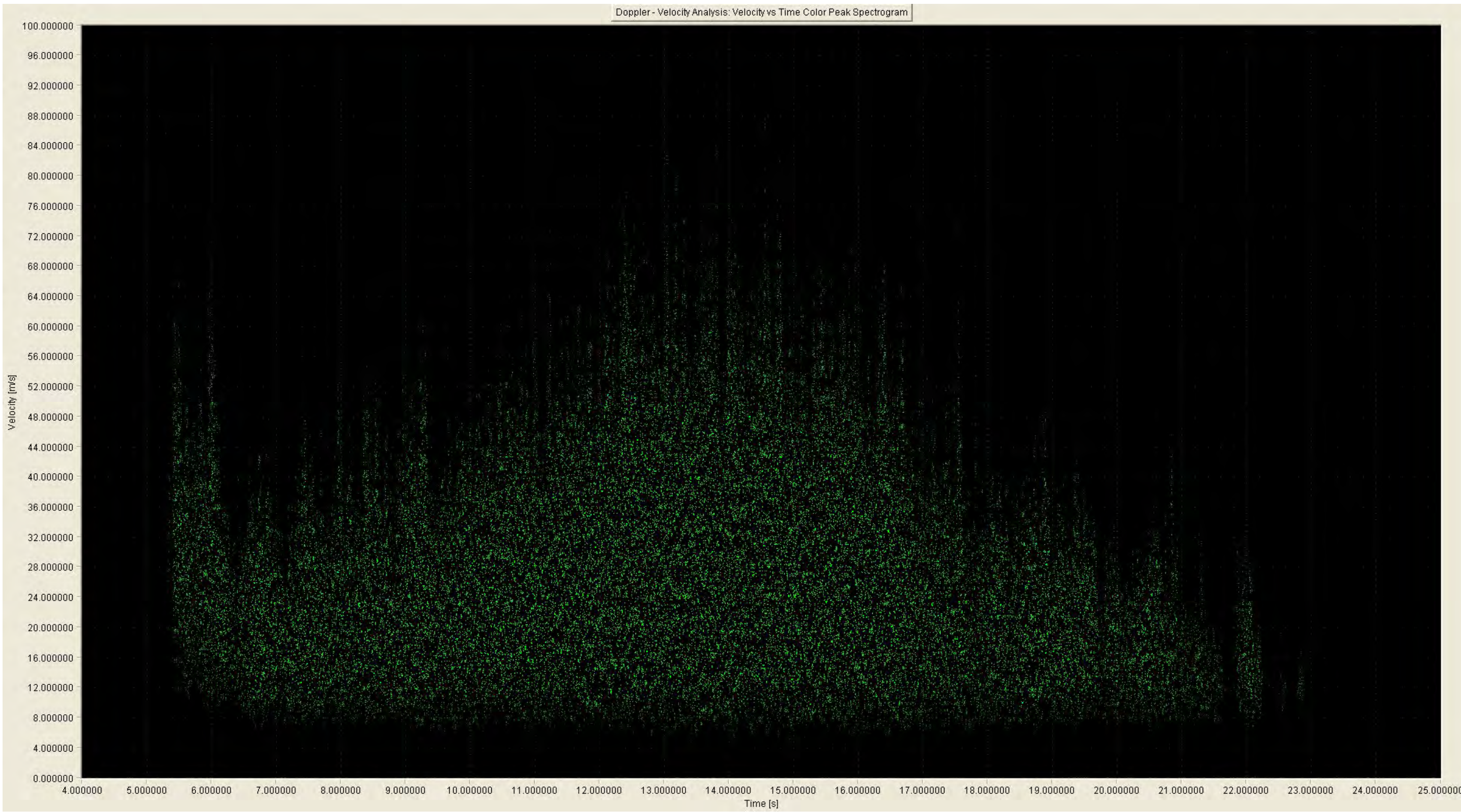

FIGURE II-D-1. Bunker 2K FFT Color DTI Plot.

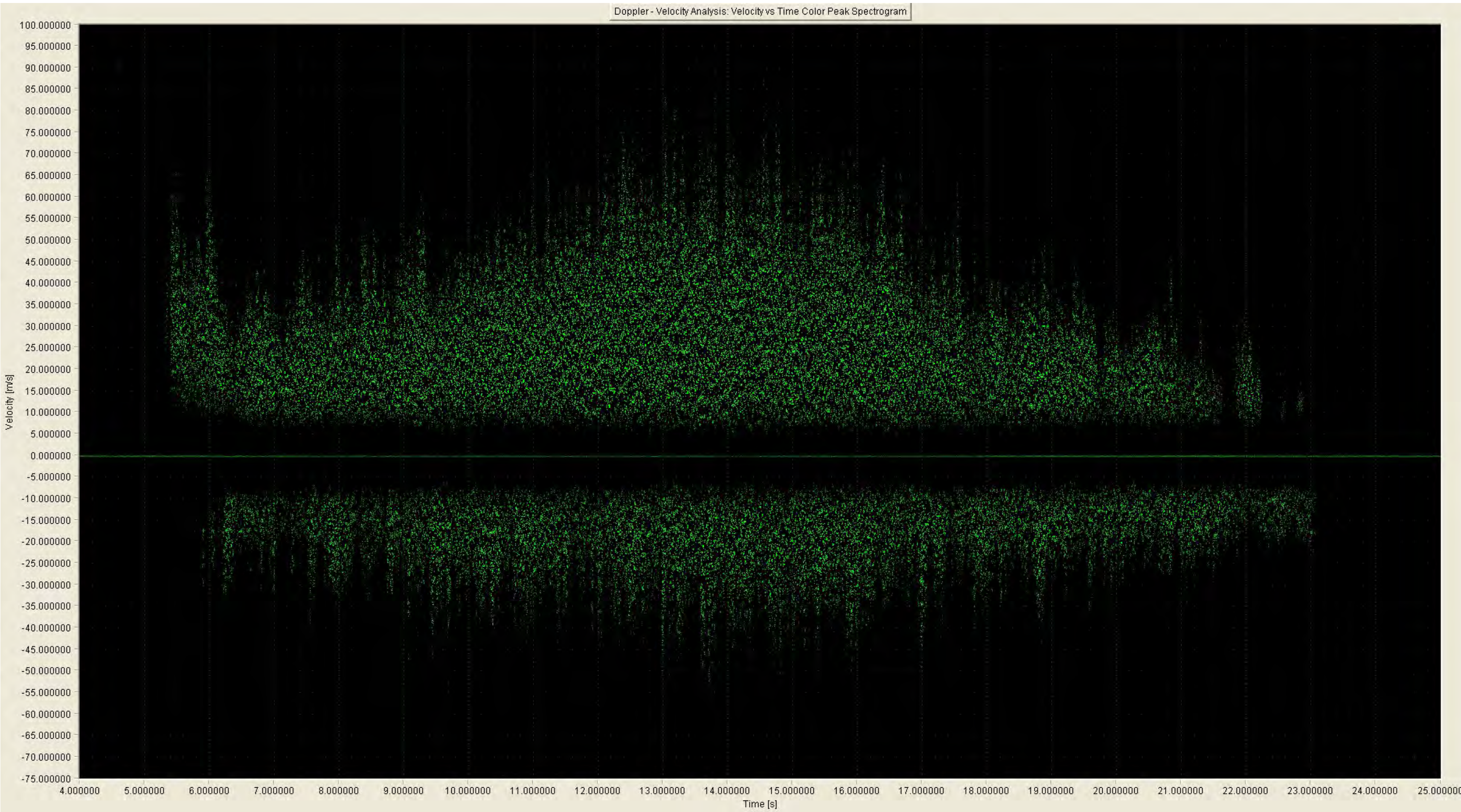

FIGURE II-D-2. Bunker 2K FFT Color DTI-0 Plot.

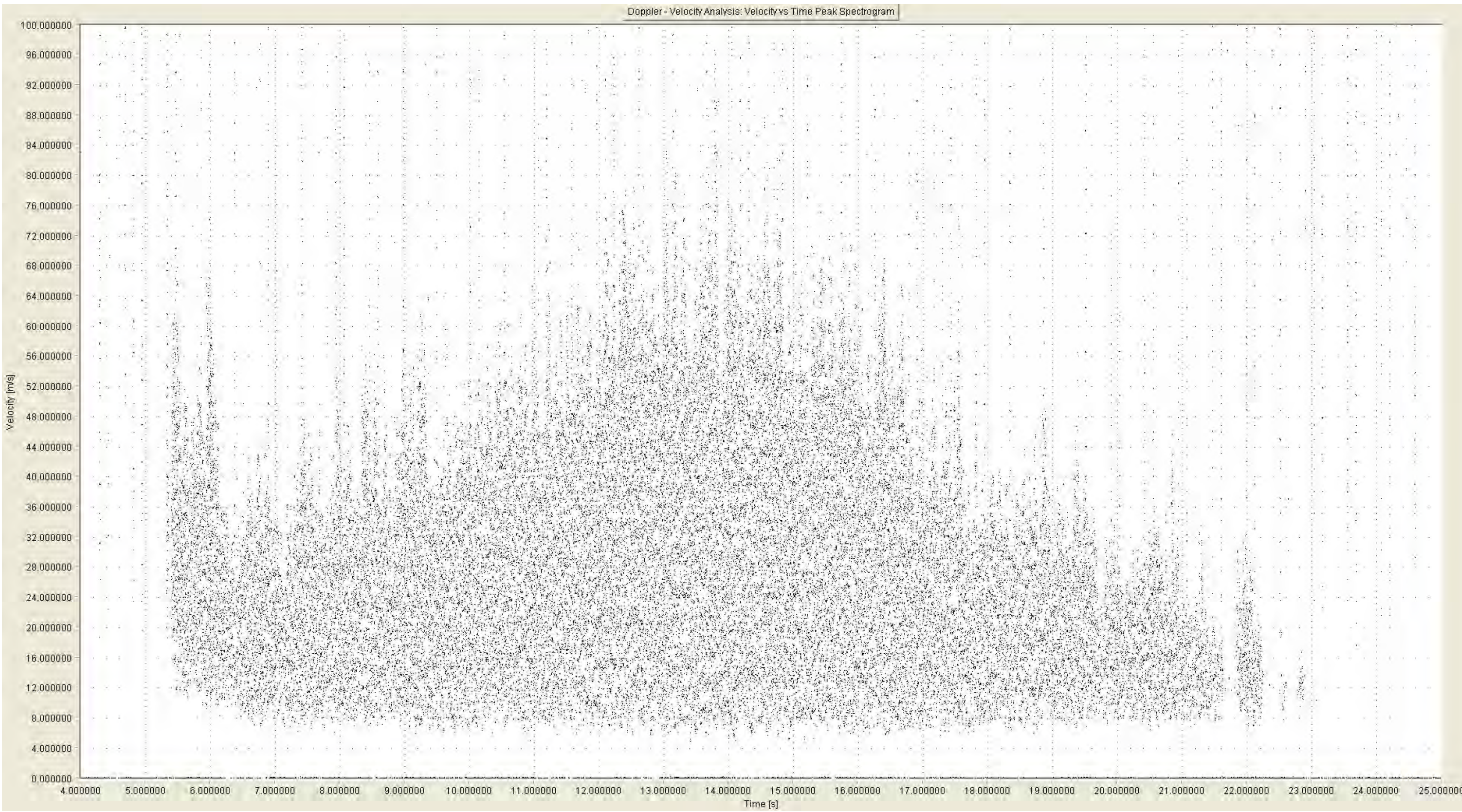

FIGURE II-D-3. Bunker 2K FFT DTI Plot.

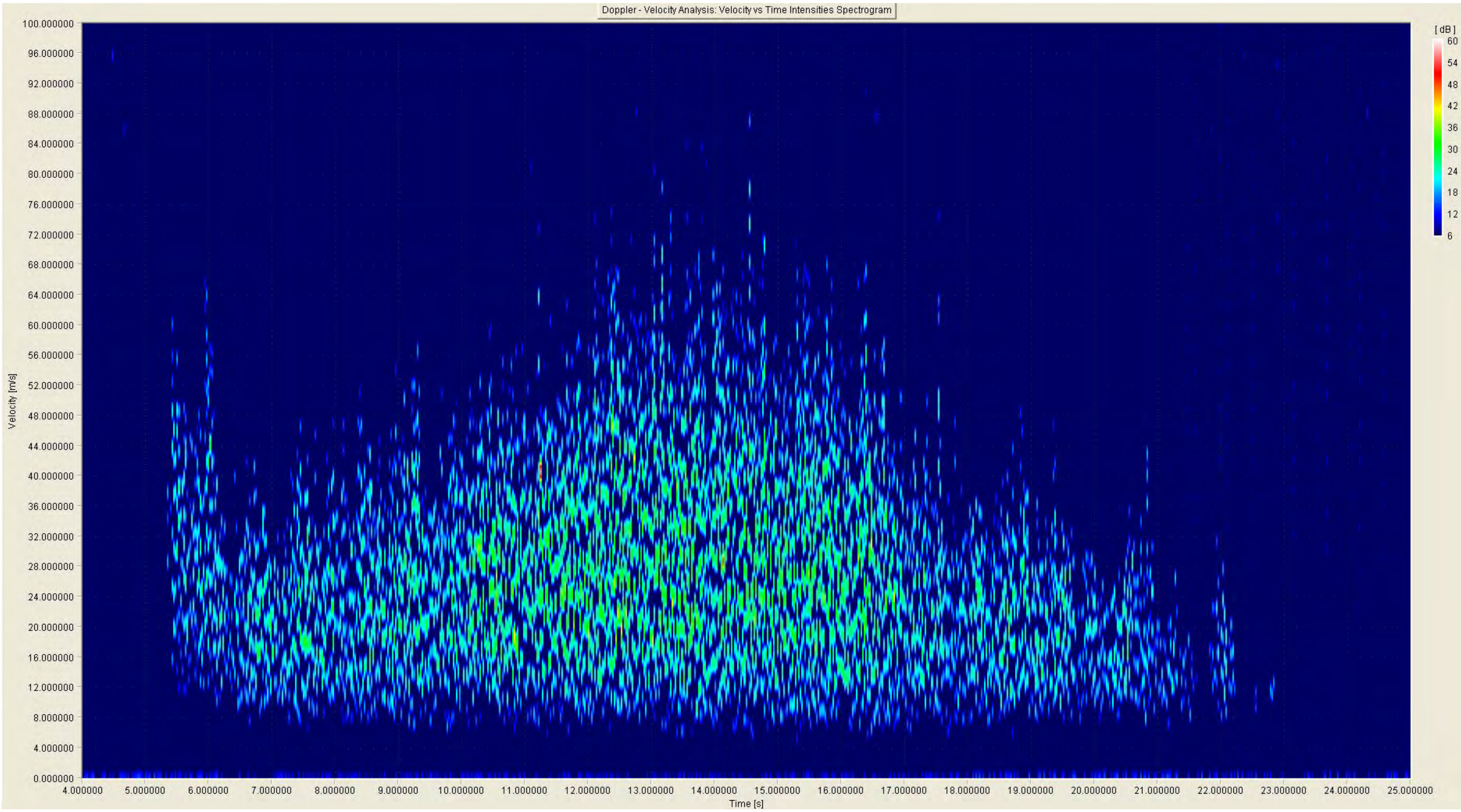

FIGURE II-D-4. Bunker 2K FFT Intensity Plot.

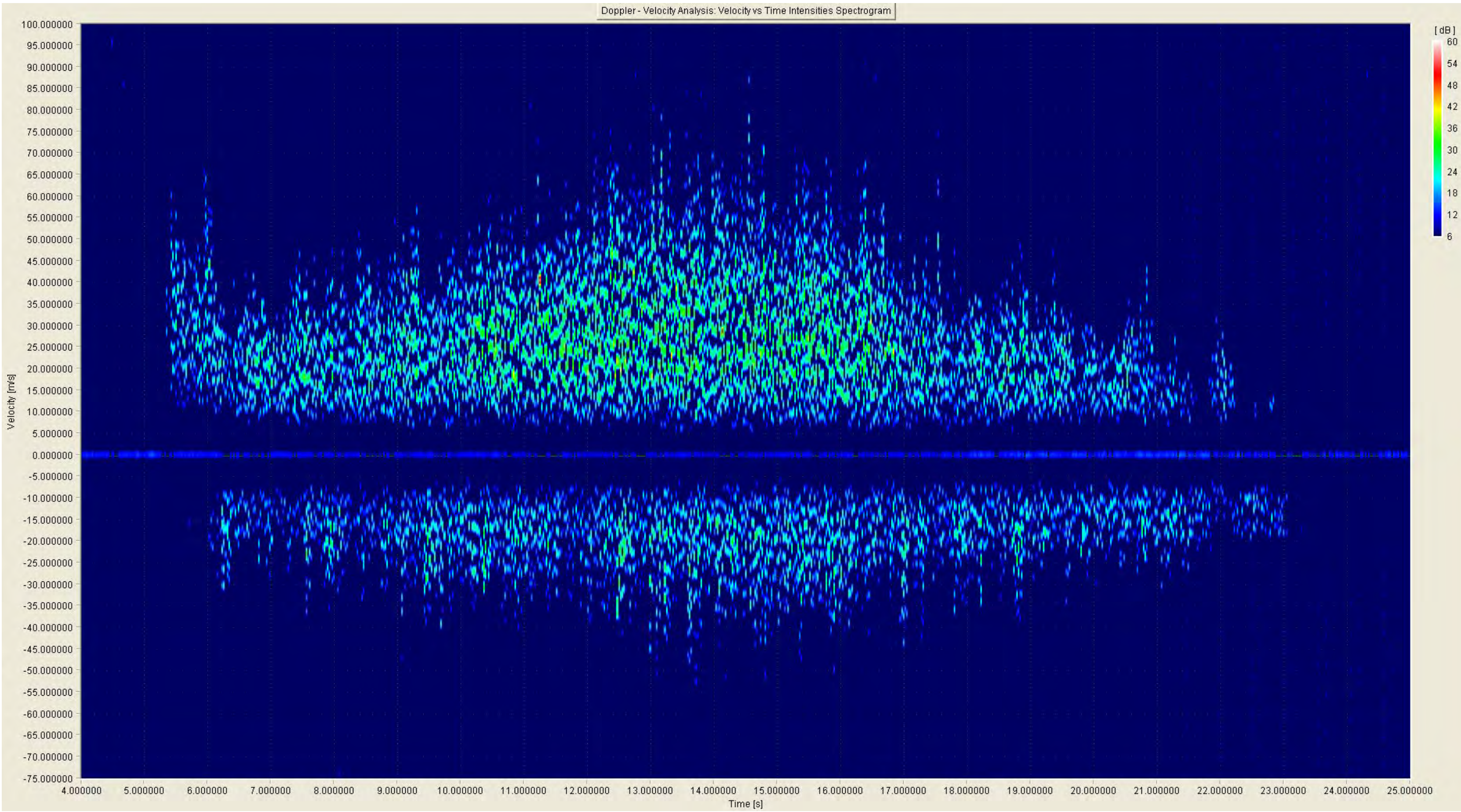

FIGURE II-D-20. Bunker 2K FFT Intensity-0 Plot.

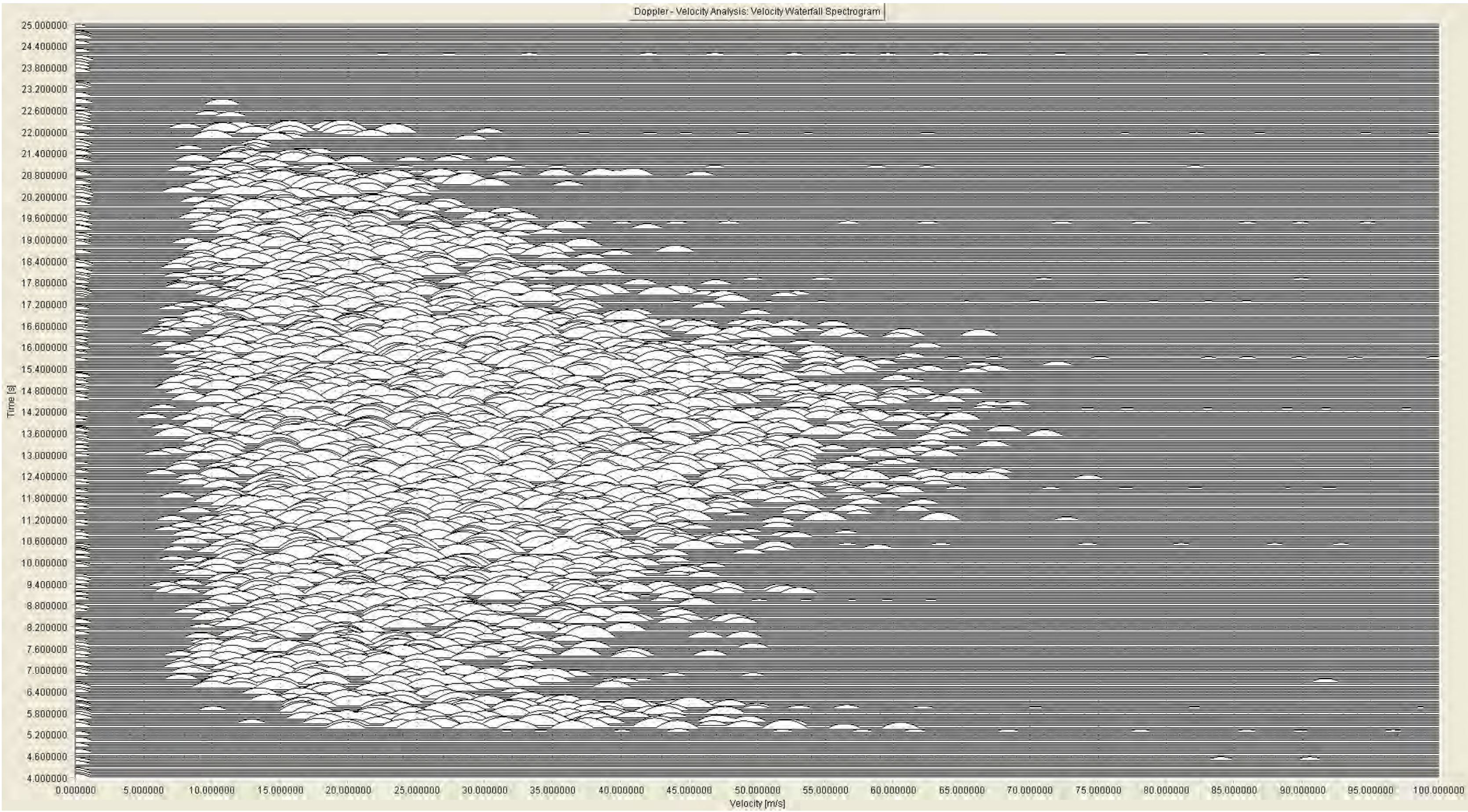

FIGURE II-D-6. Bunker 2K FFT Waterfall Plot.

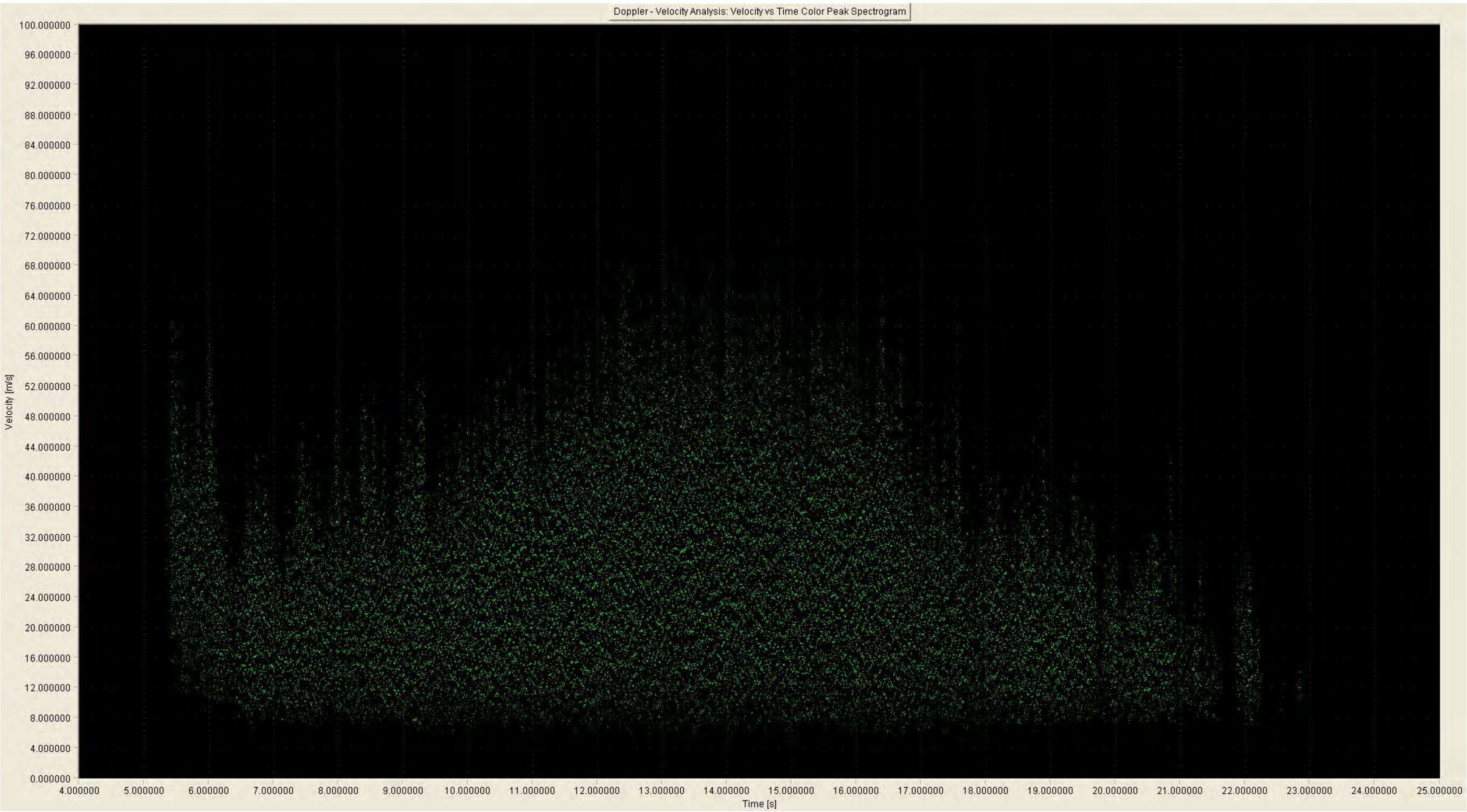

FIGURE II-D-7. Bunker 4K FFT Color DTI Plot.

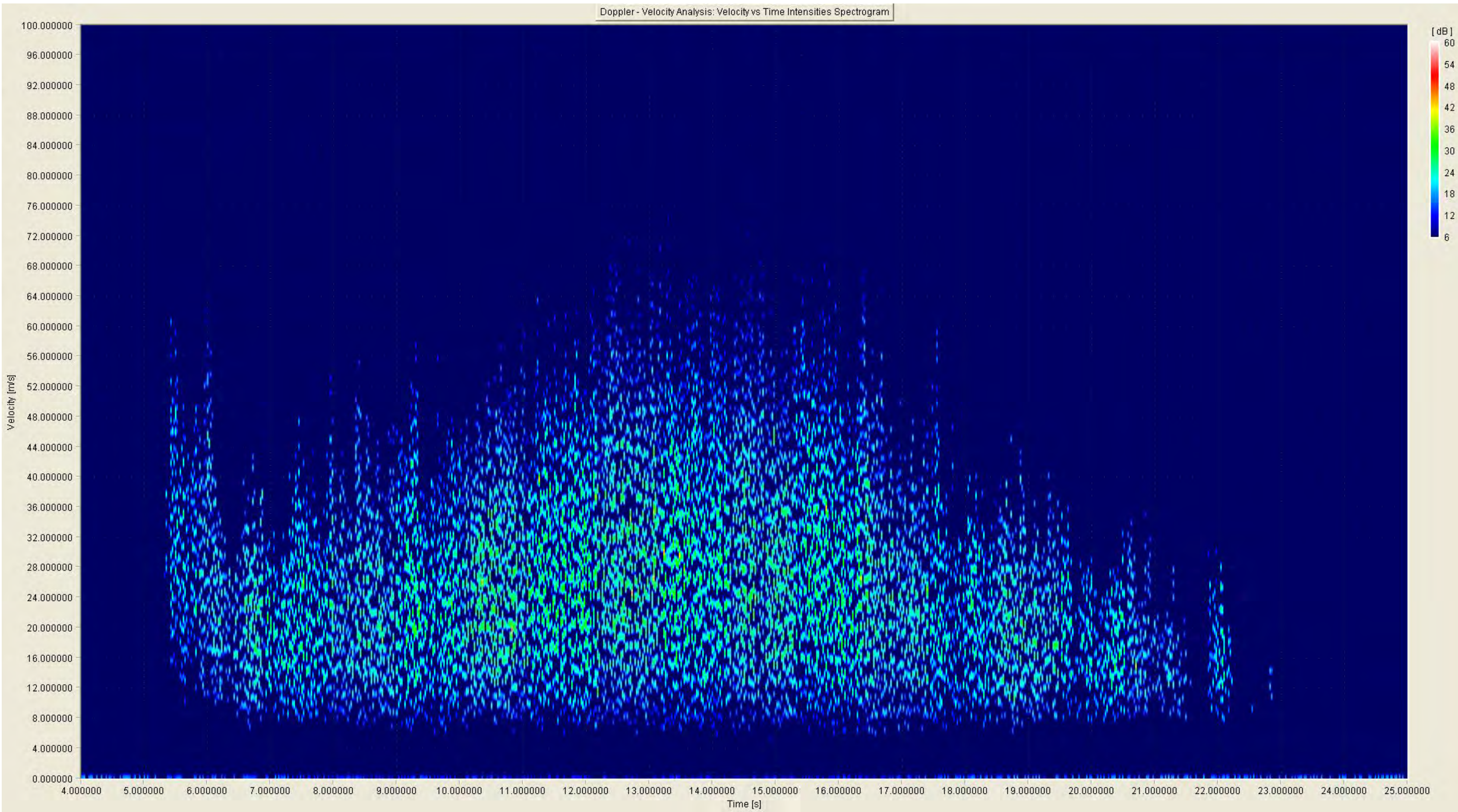

FIGURE II-D-8. Bunker 4K FFT Color DTI Plot.

Summary

- Initial Velocity of Plume 25 m/s
- Peak Velocity of Plume 90 m/s
- Duration of Plume 18 seconds

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CHAPTER III. TEST 2/VENT AREA AND LOADING DENSITY TO PRODUCE CHOKED FLOW AND RAPID PRESSURE RISE IN STRUCTURE LEADING TO RUPTURE OF STRUCTURE AND PROJECTION OF STRUCTURAL DEBRIS

Test 2 was conducted on 15 December 2012 at the Airport Lake (dry lake bed) test site at NAWCWD, China Lake, California. The structure was the same as that used in Test 1 with the exception that the closure plate bolted to the front of the structure had a smaller diameter orifice than the plate used in Test 1 (39-cm diameter versus the 79-cm diameter used in Test 1). The smaller diameter orifice was implemented to generate a choked flow condition in Test 2 that would result in the breakup of the test structure. This test would not only examine the thermal effects identified in the unchoked condition in Test 1, but also the character of the debris and its final location resulting from structural failure.

TEST CONFIGURATION

The test had 1,176 pounds of M1 gun propellant, obtained from the demilitarization account in Hawthorne, Nevada, with nominal dimensions of 1.22-mm outer diameter, 5.03-mm length, and 0.514-mm perforation diameter. The M1 propellant used for Test 2 had a single perforation in the center (1P). The M1 gun propellant was loaded in eight fiberboard drums placed on the wood pallets on the concrete floor of the structure. The bed depth of the propellant was 15 inches from the top of the barrel. The loading density was 66.68 kg of propellant per m^3 of volume in the structure.

Figure III-1 shows the containers in the structure. Point source igniters were placed in each of the drums of gun propellant. The igniter was composed of one electric match and approximately a quarter pound of smokeless powder.

INSTRUMENTATION

A surveillance camera and break wires were used in the structure to determine the mass regression rate of the propellant and to assess how the fire might propagate inside the structure. A surveillance camera was placed in the bottom corner of the west wall positioned so that it would record the ignition and the burning of the propellant. Break wires were placed between the pallet and barrels 6 and 7. Unfortunately, the heat in the structure compromised the internal camera, and the break wires shorted during the test.

FIGURE III-1. Eight Containers Holding 147 Pounds of M1 Gun Propellant for a Total Weight of 1,176 Pounds (533 kg) Used in Test 2.

GAGE LOCATIONS

The Test 2 interior gage locations are oriented with the north opening of the structure facing the reader (Figure III-2).

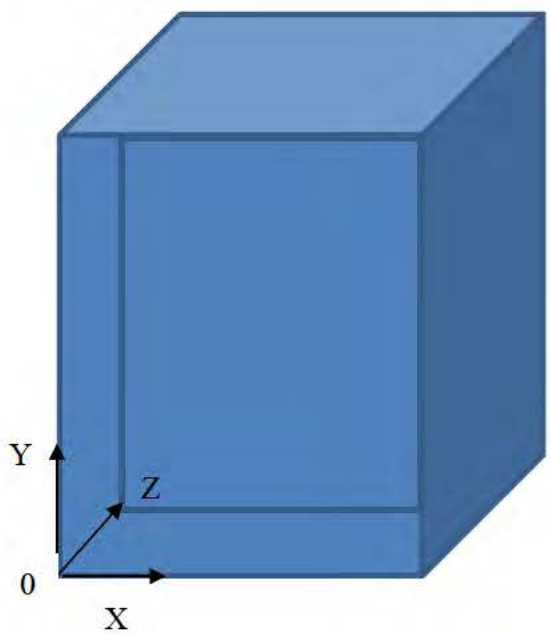

FIGURE III-2. Reference Figure for Internal Instrumentation.

Table III-1 presents the inside gage locations for Test 2. Figure III-3 lists the outside gage locations.

TABLE III-1. Gage Descriptions Inside Structure for Test 2.

		Location, inches			
Gage	**ID**	**X**	**Y**	**Z**	**Comments**
Thermocouple	1				On Barrel #7
Thermocouple	2	78.72	57.72	59.72	West wall, top, south (top-far corner*)
Thermocouple	3	78.72	56.22	6.5	West wall, bottom, north (bottom-near corner*)
Thermocouple	4	78.72	27.5	59.72	West wall, bottom, south (bottom-far corner*)
Thermocouple	5	78.72	25	5.75	West wall, top, north (top-near corner*)
Thermocouple	6	76.22	70.47	76.22	South wall, top, west (upper-right corner*)
Thermocouple	7	76.22	8.72	76.22	South wall, bottom, west (lower-right corner*)
Thermocouple	8	39.36	39.36	78.72	Centered on south wall
Thermocouple	9	3.00	70.47	75.92	South wall, top, east (upper-left corner*)
Thermocouple	10	2.5	8.00	76.22	South wall, bottom, east (lower-left corner*)
Thermocouple	11	1.75	69.97	2.75	North wall, top, west (upper-right corner*)
Thermocouple	12	2.00	8.00	2.00	North wall, bottom, west (lower-right corner*)
Thermocouple	13	39.72	75.22	8.25	North wall, top, center (above door)
Thermocouple	14	38.22	8.50	8.00	North wall, bottom, center (below door)
Thermocouple	15	75.72	70.22	3.00	North wall, top, east (upper-left corner*)
Thermocouple	16	76.72	8.72	2.00	North Wall, bottom, east (lower-left corner*)
Thermocouple	17	76.72	39.36	39.36	Centered on ceiling
Thermocouple	18	2	39.36	39.36	Centered on floor
Thermocouple	19				On barrel #6
Thermocouple	20				On barrel #2
DFT	16	0	47.5	34.5	East wall centered
DFT	17	78.72	47.5	34.5	West wall centered
Pressure	PI-1	78.72	61.00	29.72	West wall centered
Pressure	PI-2	78.72	59.25	37.22	West wall–Stunt
Pressure	PI-3	39.00	36.72	78.72	South wall centered
Pressure	PI-4	0	41.125	40.50	East wall centered
Pressure	PI-5	35.50	78.72	39.22	Ceiling centered
Pressure	PI-6	39.00	0.00	37.47	Floor centered

*Looking into the structure from north facing door.

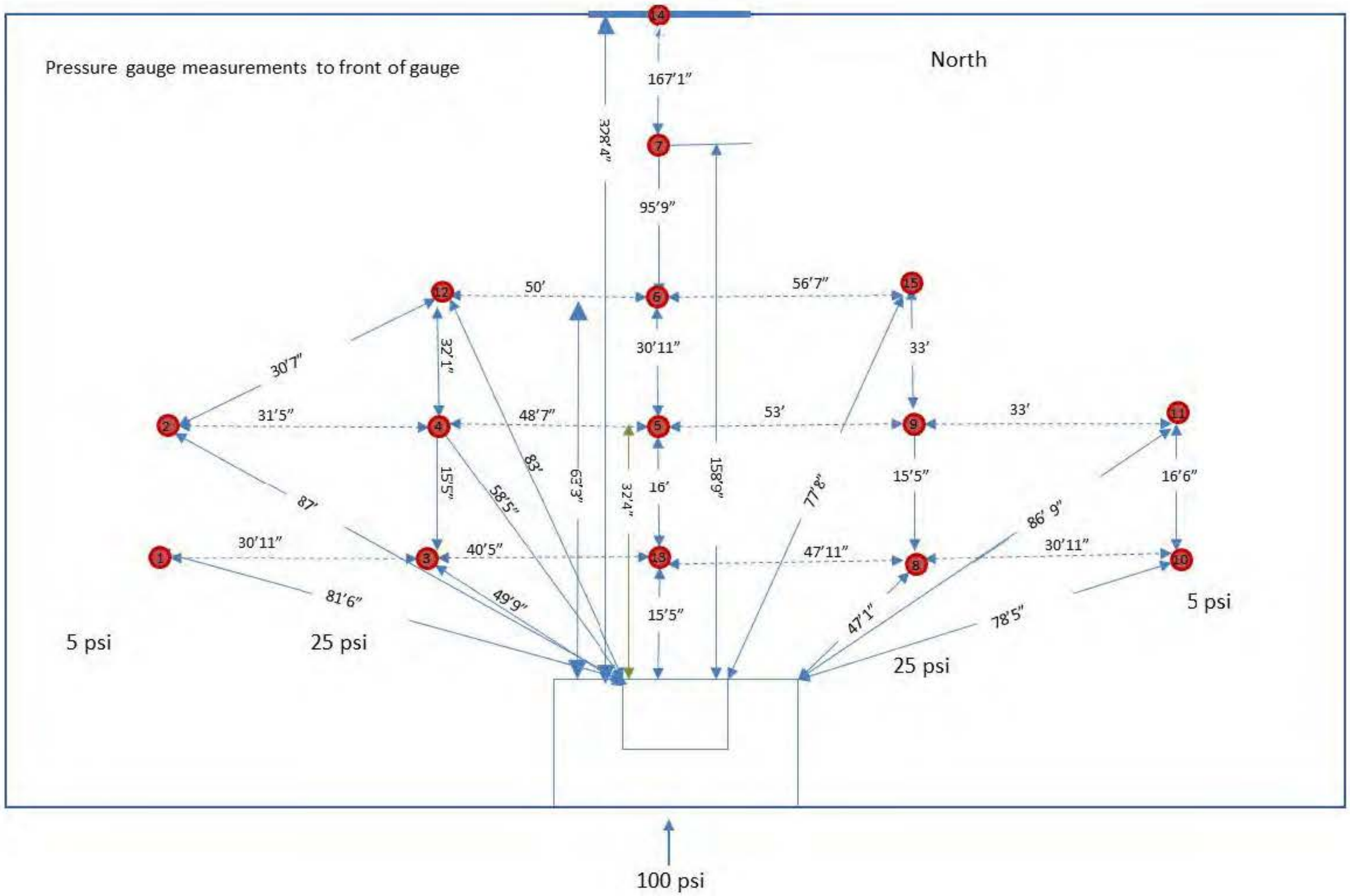

FIGURE III-3. Gage Descriptions Outside Structure for Test 2.

TEST RESULTS

INSIDE STRUCTURE

Figures III-4 through III-6 present the pressure versus time data inside the structure for gages PI-1, PI-3, and PI-4, respectively. All of the Test 2 pressure data can be found in Appendix III-A. The pressure within the structure quickly rose to between 44 and 53 psi, at which point the structure started to rupture as indicated by data from the high-speed cameras and the correlating time stamps from the photography and the pressure data. Structure failure occurred at a time between 1.401 and 1.410 seconds based on the pressure data. Ignition of the aide and flame spread into the propellant can be observed at 0.7 seconds. This observation can be made using Figures III-4, III-7, and the high-speed video data found in Appendix III-B This value is consistent with the video observations from the view of flamelets within the structure to the start of roof failure.

The temperature-time profiles for TC-8 (center of the south wall) and TC-3 (lower-north side of west wall) presented in Figures III-7 and III-8 to illustrate the temperature rise before the rupture of the structure and the continued burning of the M1 gun propellant after the rupture of the structure. Appendix III-C contains all of the Test 2 temperature and heat flux data. Figures III-C-1 through III-C-17 of Appendix III-C presents the temperature data measured inside the structure.

The TC-8 (center of the south wall) temperature plot of Figure III-7 shows a rapid temperature rise until about 820°C at 1.47 seconds and then a rapid decrease in temperature indicating thermocouple failure.

Figure III-8 presents the temperature–time data for Thermocouple TC-3 located at the lower-north side of the west wall, showing continual temperature increase after the separation of the roof from the west wall. The figure illustrates a temperature of 1,100°C at 10.8 seconds after the separation of the roof and west wall.

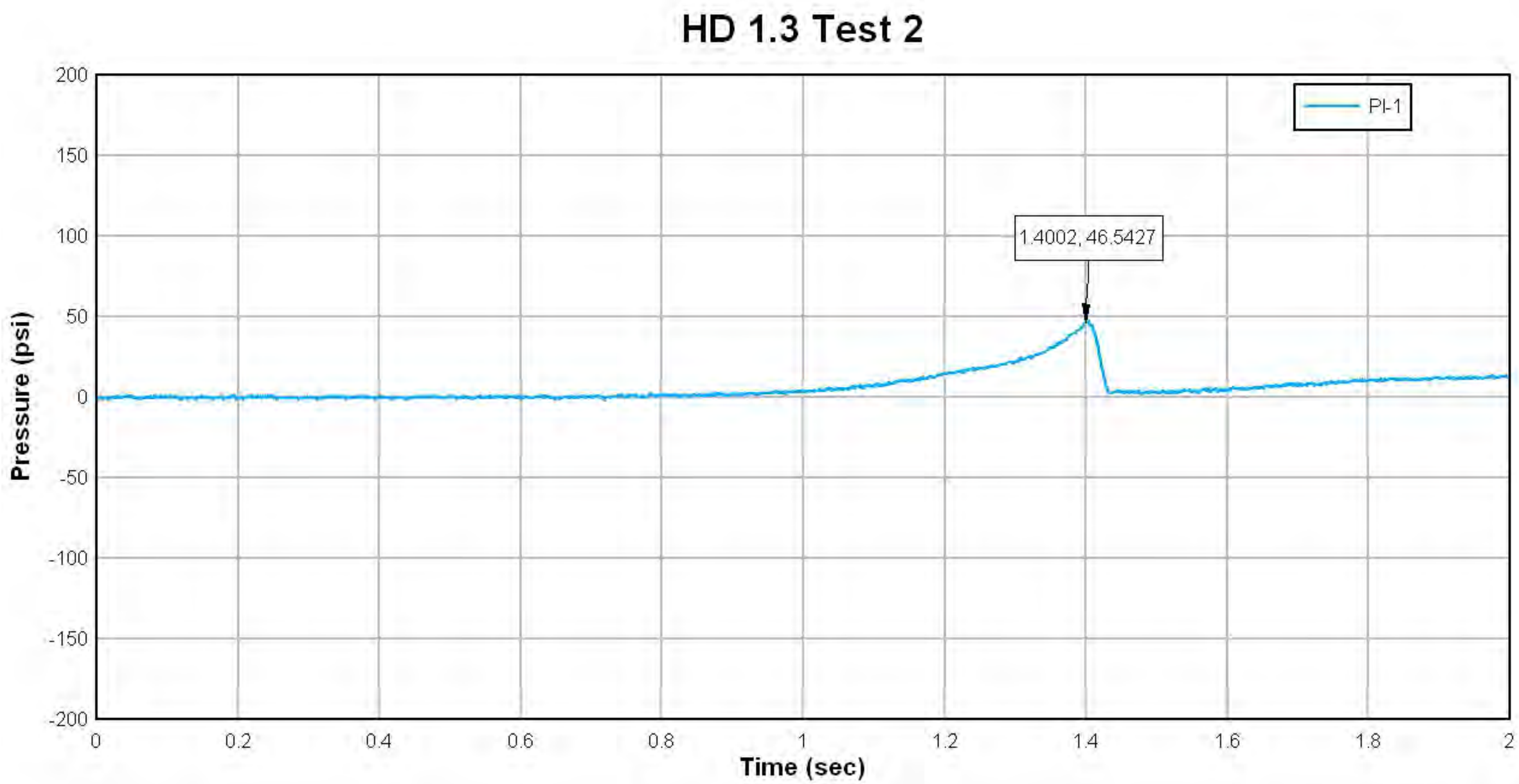

FIGURE III-4. Pressure–Time Data for PI-1 (Test 2).

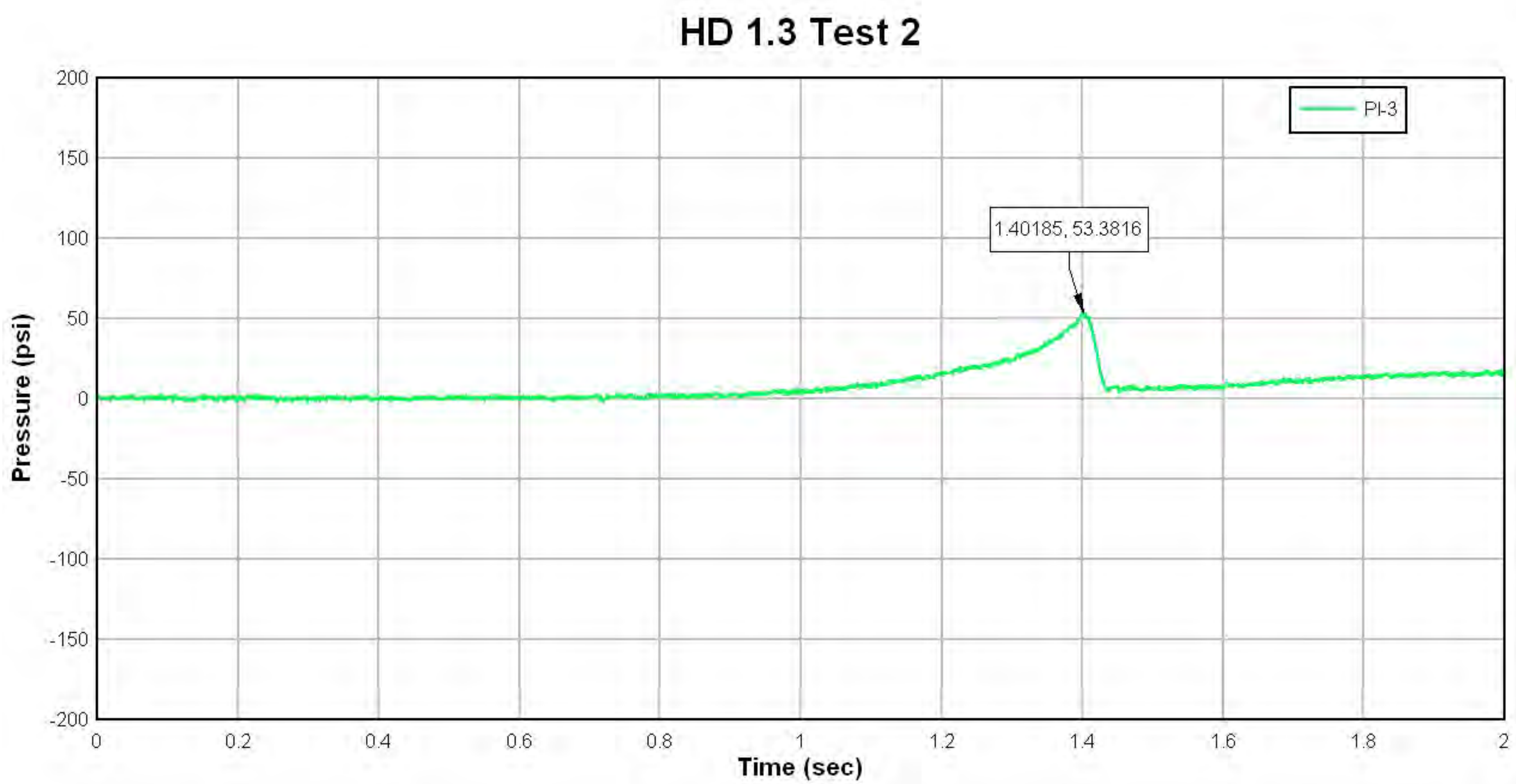

FIGURE III-5. Pressure–Time Data From PI-3 (Test 2).

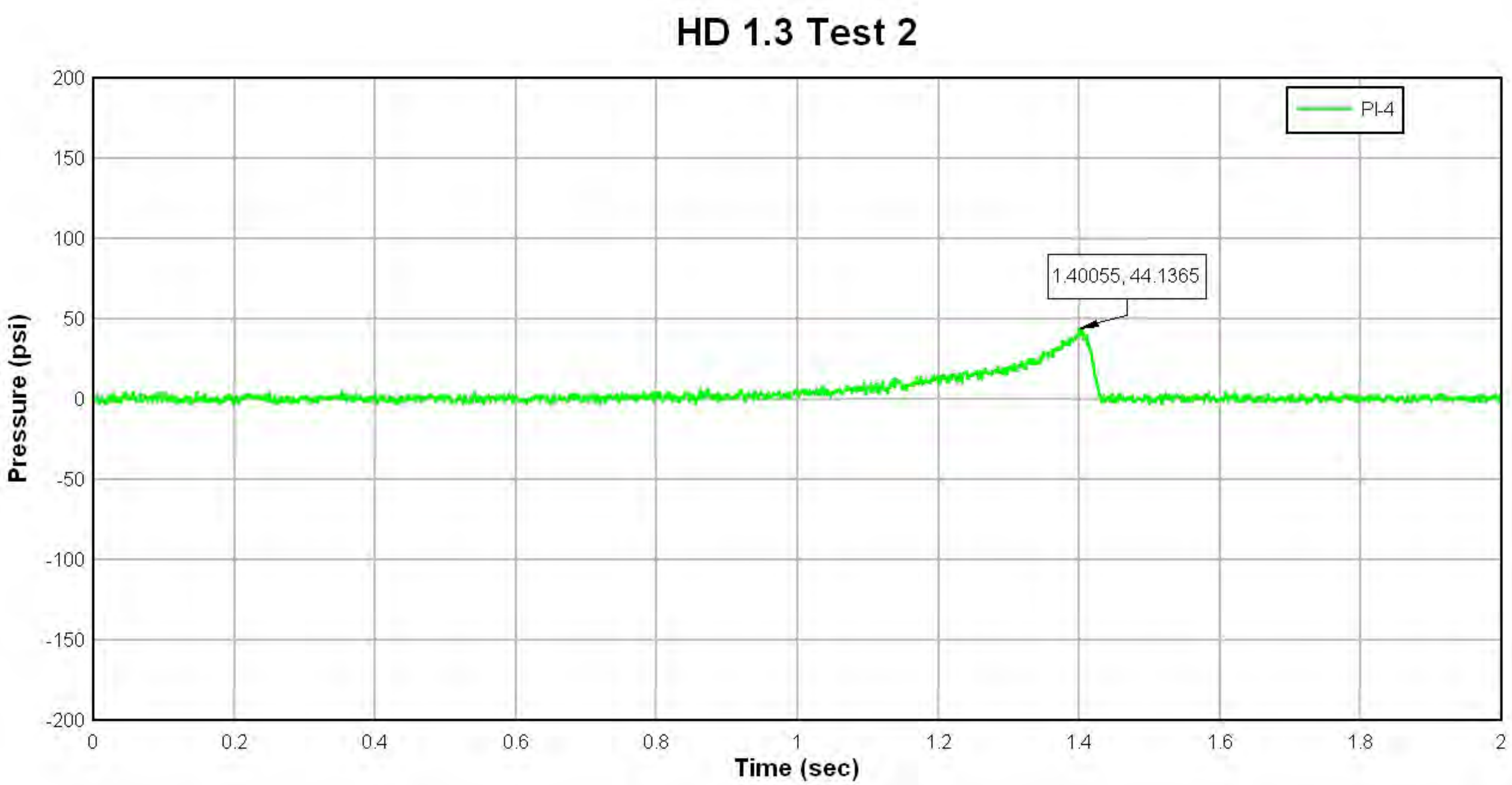

FIGURE III-6. Pressure–Time Data From PI-4 Located on East Wall (Test 2).

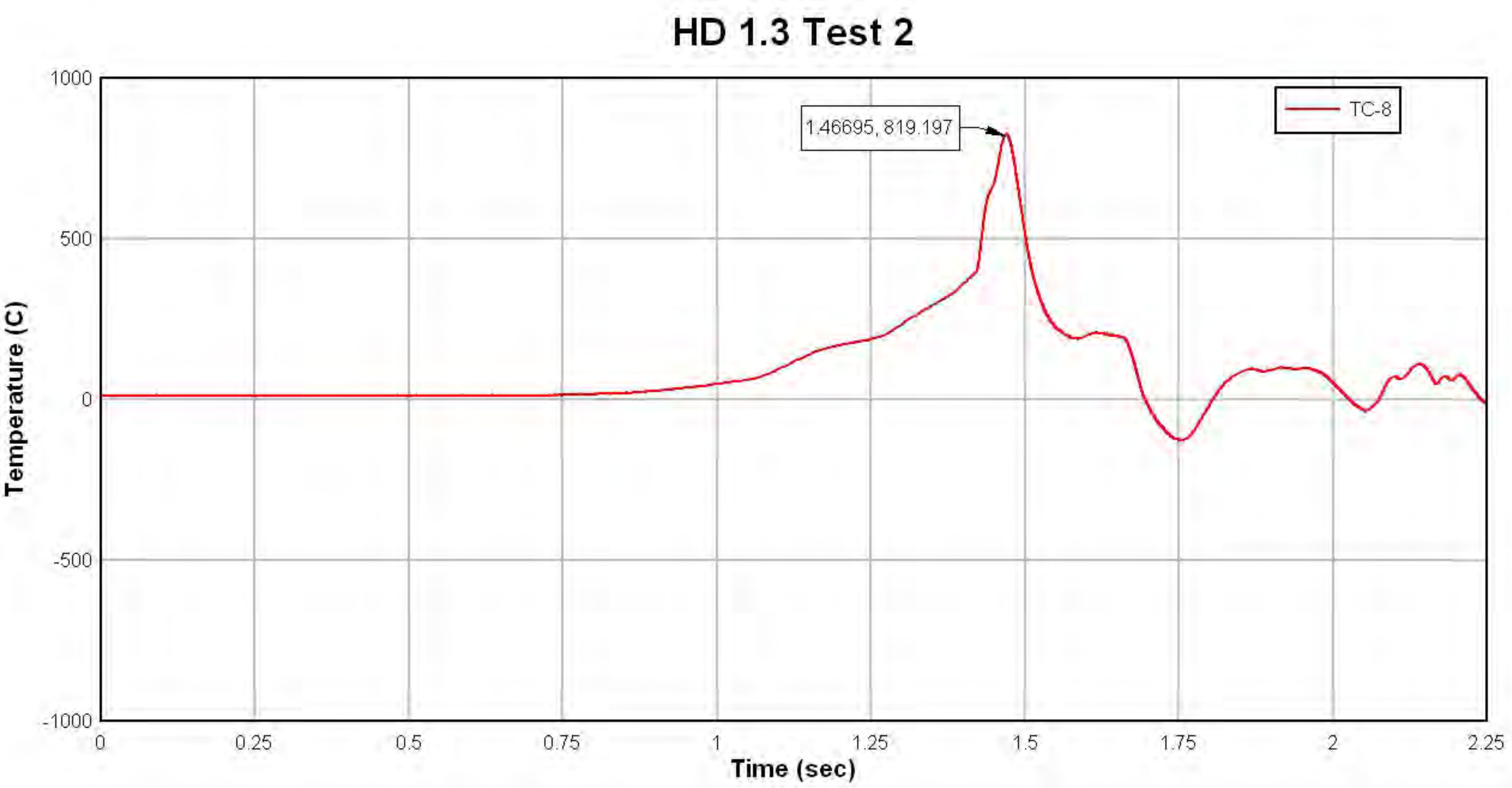

FIGURE III-7. Temperature–Time Data From Thermocouple
TC-8 Located at Center of South Wall (Test 2).

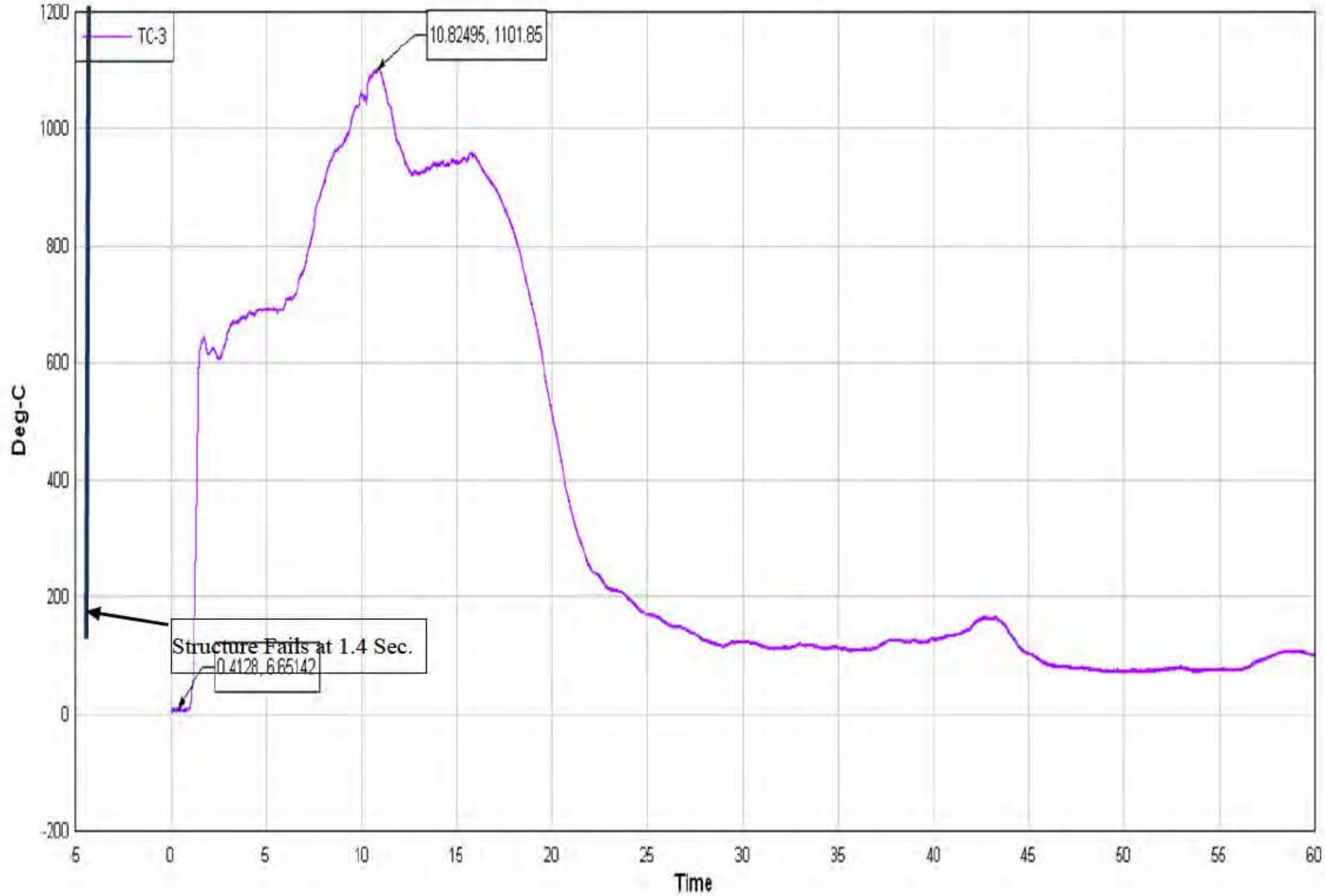

FIGURE III-8. Temperature–Time Data From Thermocouple TC-3 Located at Lower-North Side of West Wall.

When comparing the thermal plots to the high-speed video data, personnel observed that the M1 fire burned approximately 15 seconds after displacement of the roof and door from their original positions. These data indicate that much of the gun propellant continued to burn long after the confinement was released; that is, very little of the propellant had burned producing the 40 or 50 pounds of pressure that caused the roof and door to be removed. The rest of the propellant burned producing the large fireball seen after the structure failed.

Figure III-9 shows the thermal-flux levels measured inside the structure. Peak thermal-flux levels of 122.14 kW/m^2 and 158.22 kW/m^2 were measured at DFT #16 and #17 at 22.50 seconds and 11.38 seconds, respectively. Measurement of these values occurred after structure failure and is indicative of the M1 propellant combustion.

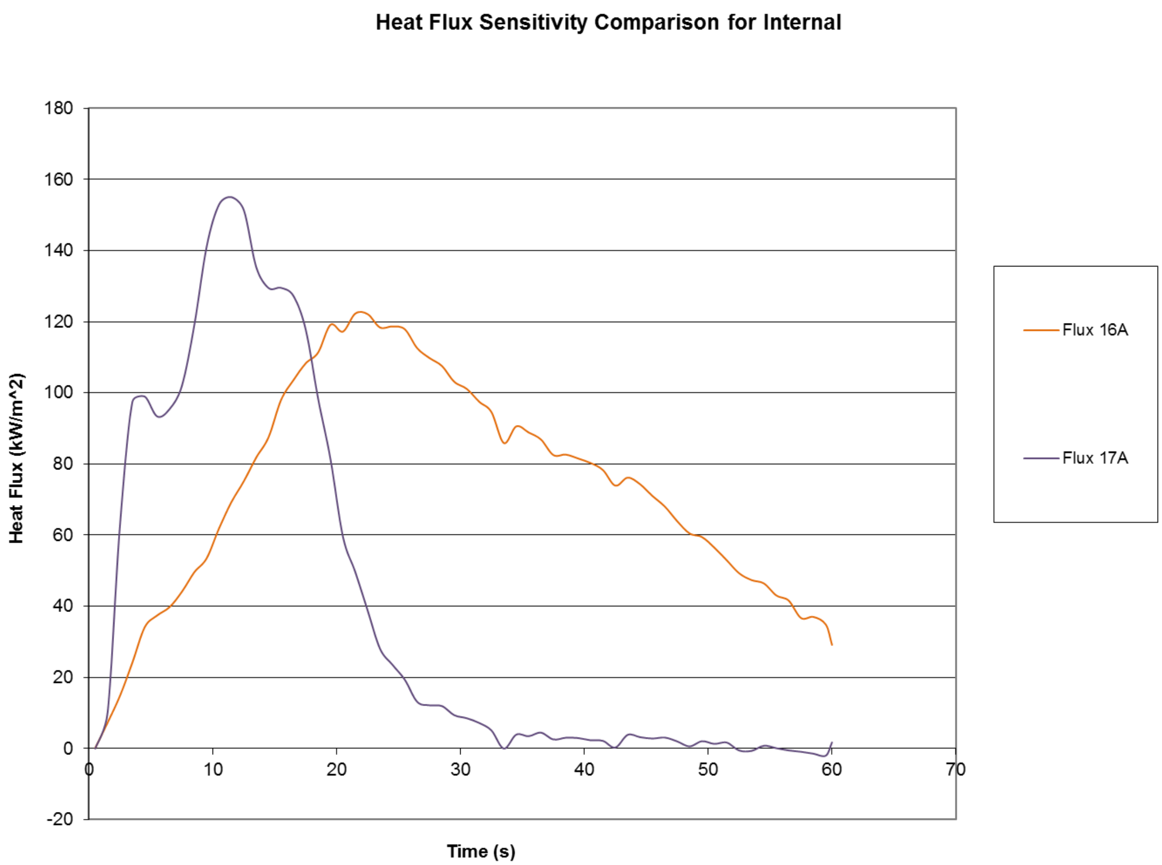

FIGURE III-9. Thermal Flux Data Measured Inside Structure (Test 2).

Figure III-10 shows the interior of the structure remaining after Test 2 as seen through the opening in the north wall. The ceiling/roof was gone and debris was remaining from the drums that contained the M1 propellant.

FIGURE III-10. Interior of Structure Remaining After Test 2.

Figure III-11 shows the corner of the north wall and west wall, indicating that it was beginning to separate. The doorframe had been on the right-hand side of the north wall. Damage is evident at the bottom of the north wall.

FIGURE III-11. Intersection of West and Portion of North Wall (Test 2).

Figure III-12 shows the intersection of the west and south wall. There is damage at the top of the joint but most of the joint is intact.

FIGURE III-12. Intersection of West Wall (Right) and South Wall (Left) (Test 2).

Figure III-13 shows the intersection of the south wall (right) and east wall (left) and shows almost no internal damage; however, there was some slight damage on the exterior.

FIGURE III-13. Intersection of South Wall (Right) and East Wall (Left) (Test 2).

Figure III-14 shows the intersection of the east wall and what remained of the north wall. Some separation occurred at the joint and damage at the middle of the wall (and there was damage at the bottom as seen in other photographs). What is left of the eastern part of the north wall shows that it bulged out relative to the original position.

FIGURE III-14. Intersection of Eastern Wall and What Was Left of Northern Wall (Test 2).

OUTSIDE STRUCTURE

Table III-2 summarizes the maximum pressure and recorded time provided by each of the pressure transducers placed outside the structure. The results are what might have been expected:

- PO-5 being on the center-line and in the plume from the orifice measuring the highest pressure just before the roof started to lift off the structure. PO-6 being on the center-line at about the extent of the plume.
- PO-7 being outside the plume at almost 159 feet from the structure.
- Other transducers showed low values of maximum pressure, with the transducers on the west showing slightly higher values than the corresponding transducer on the east.

TABLE III-2. Maximum Pressure–Time Recorded by External Pressure Transducers (Test 2).

Pressure Transducer	Distance From Centerline, feet	Distance From Plane of North Wall, feet	$P_{max,}$, psi	Time, seconds
PO-5	0	31.42	34.16	≈1.4
PO-6	0	62.33	<0.1	1.421
PO-7	0	158.08	0.058	1.561
PO-3	40.42 west	15.42	0.388	1.458
PO-4	48.58 west	31.42	0.346	1.464
PO-8	47.92east	15.42	0.268	1.456
PO-9	53 east	31.42	0.342	1.481
PO-1	82 west	15.42	0.45	1.483
PO-2	82 west	31.42	0.239	1.489
PO-10	82 east	15.42	0.191	1.483
PO-11	82 east	31.42	≈0.19	≈1.5

External temperatures were measured using the heat flux gages external to the structure. Table III-3 provides the peak temperatures and associated time at each heat flux gage location.

TABLE III-3. Peak Temperature and Time at Gages Outside Structure.

Heat flux Gage	Distance From Centerline, feet	Distance From Plane of North Wall, feet	$T_{max,}$, C	Time, seconds
DFT-5	0	31.42	164.66	1.5
DFT-6	0	62.33	62.4	16.58
DFT-7	0	158.08	46.54	18.78
DFT-3	40.42 west	15.42	79.96	21.52
DFT-4	48.58 west	31.42	74.24	20.81
DFT-8	47.92east	15.42	37.94	21.65
DFT-9	53 east	31.42	38.51	15.95
DFT-1	82 west	15.42	54.09	19.2
DFT-2	82 west	31.42	41.94	16.9
DFT-10	82 east	15.42	26.46	17.25
DFT-11	82 east	31.42	24.74	17.57
DFT-12	50 west	62.33	53.32	18.83
DFT-13	0	15.42	161.74	8.12
DFT-14	0	325.17	36.99	13.96
DFT-15	56.58	62.33	47.47	18.89

Note should be taken that seven gages reached temperatures above 50°C. Of those seven, two gages reached temperatures above 100°C. The gage and the duration at which each gage remained above 50°C are noted in Table III-4. Plots of the thermal-flux data can be found in Appendix III-C.

TABLE III-4. Time Duration Above 50°C.

Heat flux gage	Time above 50°C, seconds
DFT-1	56
DFT-3	156.69
DFT-4	119.95
DFT-5	0.08*
DFT-6	52.59
DFT-12	18
DFT-13	61

*DFT-5 stand fell out of plume during test

Figure III-15 presents the peak heat flux data measured external to the structure at DFT #13 located in direct alignment with the structure at 15 feet. A thermal flux of approximately 900 kW/m^2 occurred when the structure ruptured followed by the lower fluxes from the fireball. The highest flux from outside of the fireball was 48.31 kW/m^2 after 6.5 seconds at DFT#4 located 32 feet from the structure and 48 feet from the center

line. Individual flux profiles are located in Appendix III-C. The change in flux at structural failure is attributed to the changes in directionality of the plume/fireball with the fireball no longer directly impinging in the external instrumentation as seen in the camera images.

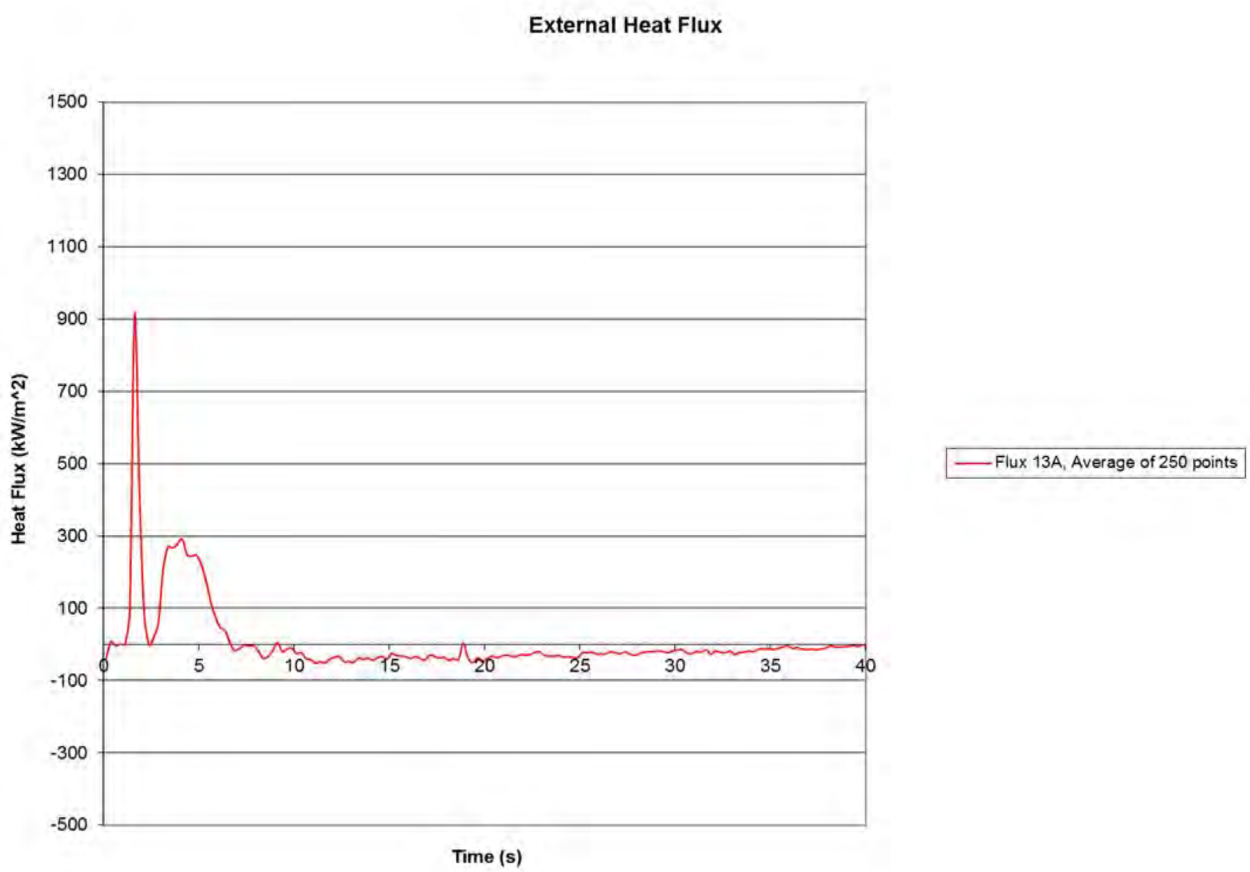

FIGURE III-15. Peak Heat Flux Measured
Outside Structure (Test 2, DFT#13).

Approximately 1.4 seconds after ignition of the gun propellant, the roof and door frame/plate separated from the structure, and a very large fireball was seen. The fireball persisted for at least 15 seconds. Figures III-16 through III-20 present still pictures taken from the video showing the plume, the rupture of the structure, and the fireball following rupture of the structure.

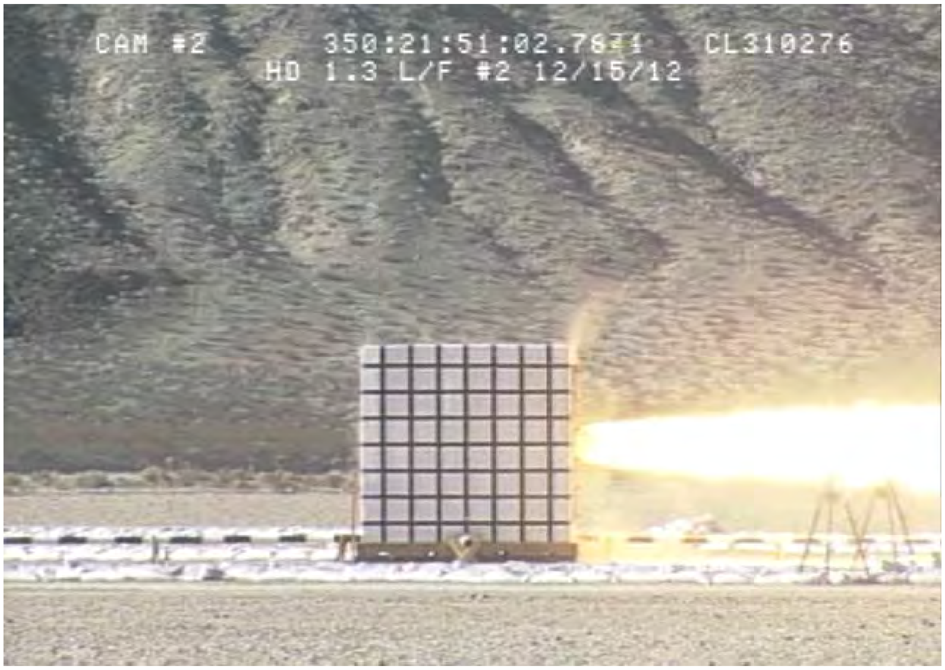

FIGURE III-16. Still Picture Taken From Video
of Test 2 at 1.5 Seconds After Ignition.
The plume is indicative of choked flow.

FIGURE III-17. Still Picture Taken From Video of Test 2 at Slightly
Under 2 Seconds After Ignition, Showing Rupture
of Structure and Resulting Fireball.

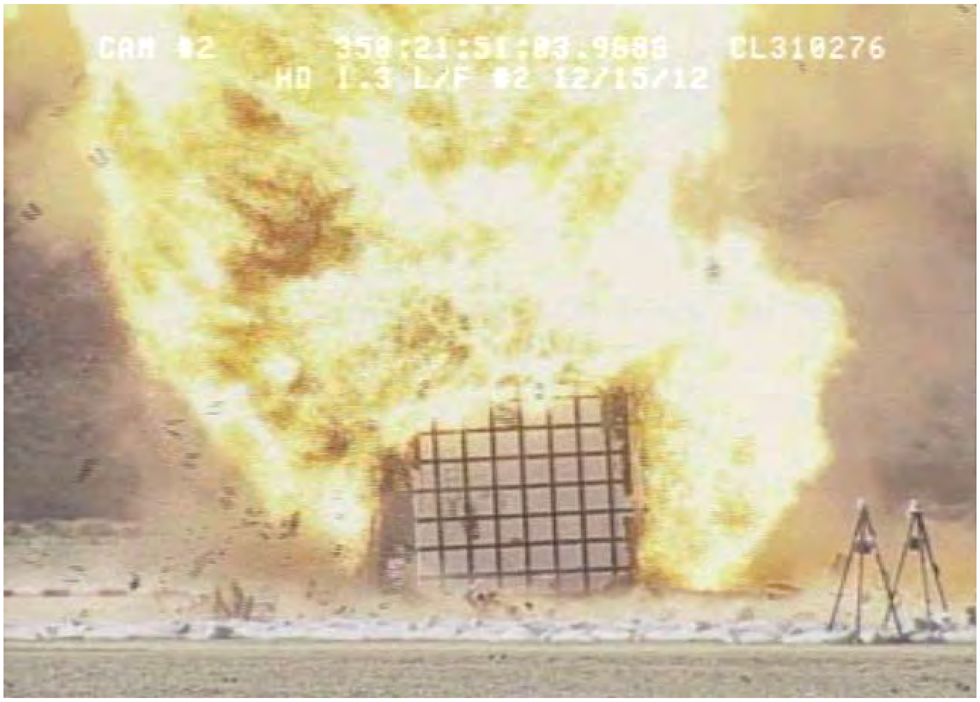

FIGURE III-18. Still Picture Taken From Video
of Test 2 at 3 Seconds After Ignition.

FIGURE III-19. Still Picture Taken From Video of
Test 2 Taken at 5 Seconds After Ignition.

FIGURE III-20. Still Picture Taken From Video of
Test 2 at 17 Seconds After Ignition.

High-speed video was taken from four locations in the north, east, south, and west relative to the structure. The framing rate in the videos was 156.25 microseconds (μs) per frame. The videos had inter-range instrumentation group (IRIG) timing associated with each frame, so it was easy to correlate what was seen in one video with something seen in another video. The time sequence is summarized in Table III-5 with the detailed timeline in Appendix III-D comprised of an Excel spreadsheet with events as seen from all four locations listed in time sequence. In Table III-5, the IRIG timing is not shown. Only the delta time from the first indication of flamelets in the structure is provided. It should be noted that there was a 0.63-second delay between ignition and first indication of flamelets in the structure.

TABLE III-5. Time Sequence Summary.

Time, seconds	Event
0.0000	First indication of flamelets in structure
0.79687	Flame fully developed in structure
0.549997	Plume diameter ≈ diameter of orifice
0.635938	Good robust plume
0.753750	Roof starts to bow
0.765782	Roof rising
0.770938	Rupture of roof and north wall joint with smoke and flame
0.771562	Flame top of door on east side, door separating from north wall at top
0.774063	Roof rising and separating from east and west walls as evidenced by smoke, plume still robust
0.774375	Top of door moving out from north wall
0.776250	Significant flame/fireball west wall/roof, plume deflects down as door separating from north wall at top and pivoting out
0.781875	Front (north side) of roof lifting off, large fireball on north and west
0.783750	Huge fireball engulfs structure
0.786564	Roof almost entirely detached from north, east, and west walls
0.799063	No plume per se, fireball in northwest quadrant, roof only attached at south wall
0.800155	Roof at ≈45 degrees from horizontal pivoting about south wall
0.813124	North wall expanding out, door being expelled, roof ≈60 degrees from original horizontal
0.819688	First fragments visible, huge fireball engulfs structure
0.822499	Fragmentation at edges of roof
0.824688	Large fireball north wall, roof; fire out east wall/roof joint; door still attached at bottom with top pivoting out
0.828281	Huge fireball, roof rising, roof breaking up
0.835624	Start to see fragments in/through fireball
0.842812	Large fragments expelled from north edge of roof
0.850157	Roof approaching vertical, breaking up, huge fireball out front
0.850625	Huge fragments being accelerated, about ½ of north part of roof being reduced to rubble
0.870000	Door still attached at bottom but pivoting out ≈45 degrees, can still see orifice; massive fireball, fragments; large fragments from north wall/roof area; looks like concrete above door breaking into very large fragments; fire out roof/east wall joint

TABLE III-5. Time Sequence Summary (Contd).

Time, seconds	Event
0.875626	Remainder of roof vertical, top of door/frame falling (≈45 degrees from vertical) with bottom still anchored in place, large fragments from roof and north wall traveling outward
0.876718	As roof rotates it continues to fragment and “throws” resulting fragments
0.895000	Large fragments from roof and north wall area above door, one large fragment with two black stripes on white background seen in multiple videos, door still pivoting with bottom still attached, east wall still nearly intact, south and west walls still intact and directing flame/fireball outward to north
1.016875	Door completely on ground having pivoted about lower edge, big fireball above roof, very large fragments
1.041250	Roof at ≈ 180 degrees from original position, south and east walls relatively intact
1.136094	Movement of structure
1.306406	Remainder of roof hits south wall, still big fireball and fragments in air
1.387187	Still large fireball and big fragments; east, south and west walls still standing
1.504845	Still big fireball and still lots of big fragments in air

High-speed video coverage stopped prior to extinguishment of the fireball. Standard video showed that the fire continued to burn until about 15 seconds after it was first observed in the structure. The combustion of the gun propellant was at one atmosphere pressure for most of that time because the roof and door were no longer in place.

Still photography was used to record the structure appearance following the test. Figure III-21 shows the two parts of the northern wall bowed out, the expelled doorframe, and the plate in front of the north wall. This figure also shows the damage to the east wall and north wall junction.

FIGURE III-21. Two Parts of North Wall Bowed Out and Door Frame and Plate Resting on Ground in Front (Test 2). This figure also shows the damage to the east wall and north wall junction.

Figure III-22 shows the floor of the structure, the doorframe, and the plate.

FIGURE III-22. Floor of Structure, Doorframe, and Plate (Test 2).

Figure III-23 shows the doorframe attached plate with orifice on the ground in front of the structure. Also shown are gray fragments that came from the north wall.

FIGURE III-23. Door Frame, Attached Plate With Orifice in Front of Structure (Test 2).

Figure III-24 shows the west wall of the structure after the test; the wall shows very little damage except at the north wall/west wall junction. The rebar shown at the right of the figure was part of what remained of the roof.

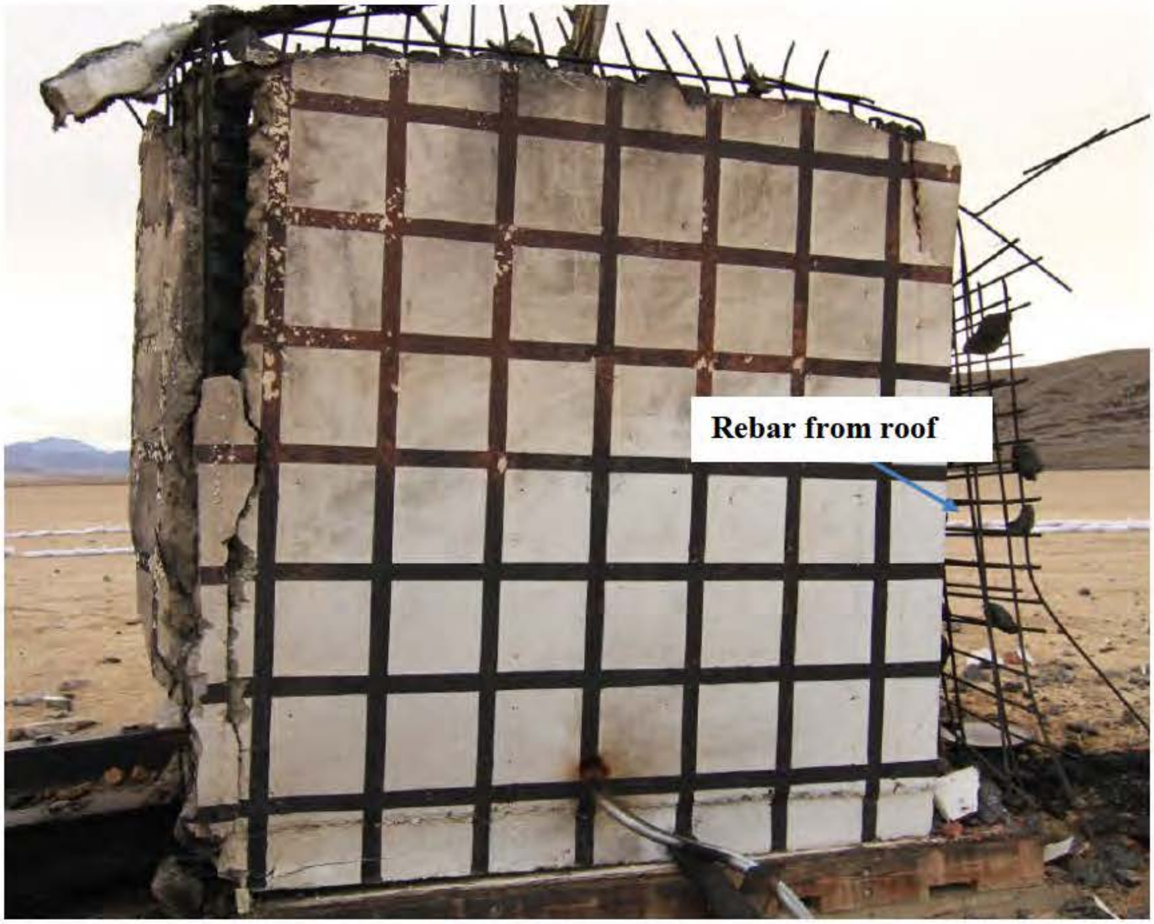

FIGURE III-24. West Wall After Test 2.
The rebar at the right was part
of what was left of the roof.

Figure III-25 shows the upper portion of the western wall/northern wall intersection.

FIGURE III-25. Upper Portion of Western Wall/Northern Wall Intersection (Test 2).

Figure III-26 shows what was left of the roof that came to rest against the south (rear) wall. Most of the roof fragmented and dispersed as the roof was pivoting about the south wall intersection. Much of the rebar is still in place, but the concrete around it has pulled away as fragments.

FIGURE III-26. What Was Left of Roof at
Rest Against South Wall (Test 2).

Figure III-27 shows that the structure was displaced from its original position on the pallet. The edge of the structure originally had been even with the front of wooden pallet. The displacement can also be seen at the rear of the pallet in Figure III-28.

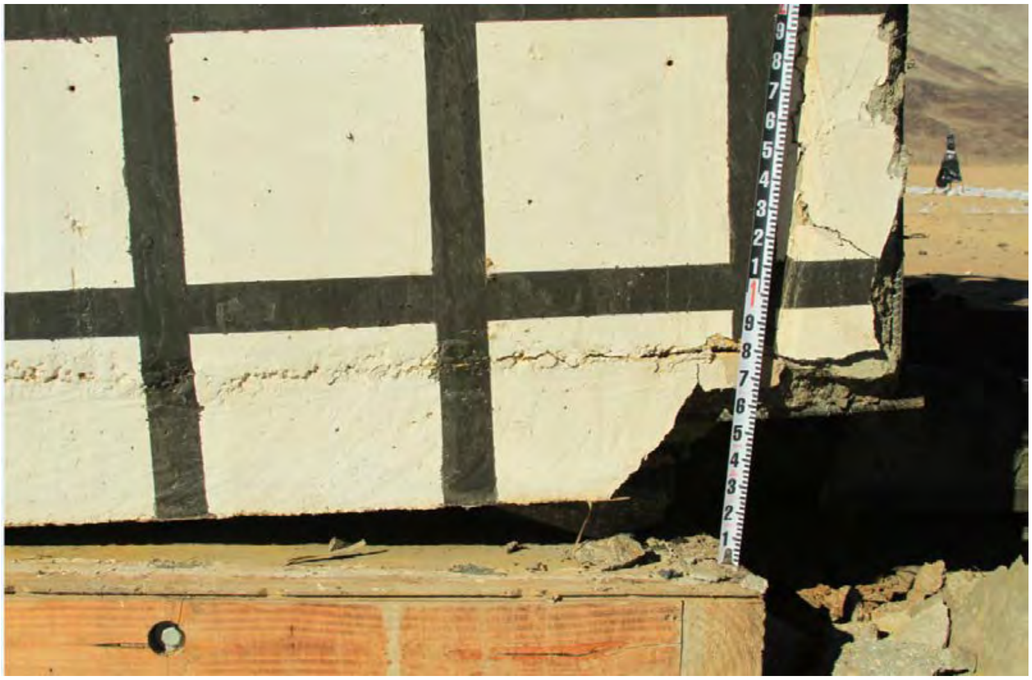

FIGURE III-27. Showing Displacement of
Structure Relative to Pallet (Test 2).
Structure displaced north.

FIGURE III-28. East Wall/South Wall Intersection Displaced North by
Almost a Foot From its Original Position on Pallet (Test 2).

In addition to high-speed video coverage, IR cameras were used to gather the signature of the plume and fireball. Frames from the IR camera have been taken and are displayed in Figures III-29 and 30. Additional footage from the IR cameras can be found in Appendix III-E.

FIGURE III-29. Camera 1 IR Image From Test 2.

FIGURE III-30. Camera 2 IR Image From Test 2.

Doppler radar captured the velocity of the plume in Test 2. The plume was detected by the radar at 5.4 seconds with a velocity of 19 m/s. The velocity of the plume peaked at 138 m/s before retreating into the structure at a velocity of 208 m/s. Unfortunately, the velocity of the individual fragments could not be determined by Doppler radar. Figure III-31 provides an intensity profile of the plume in Test 2. Additional intensity profiles can be found in Appendix III-F.

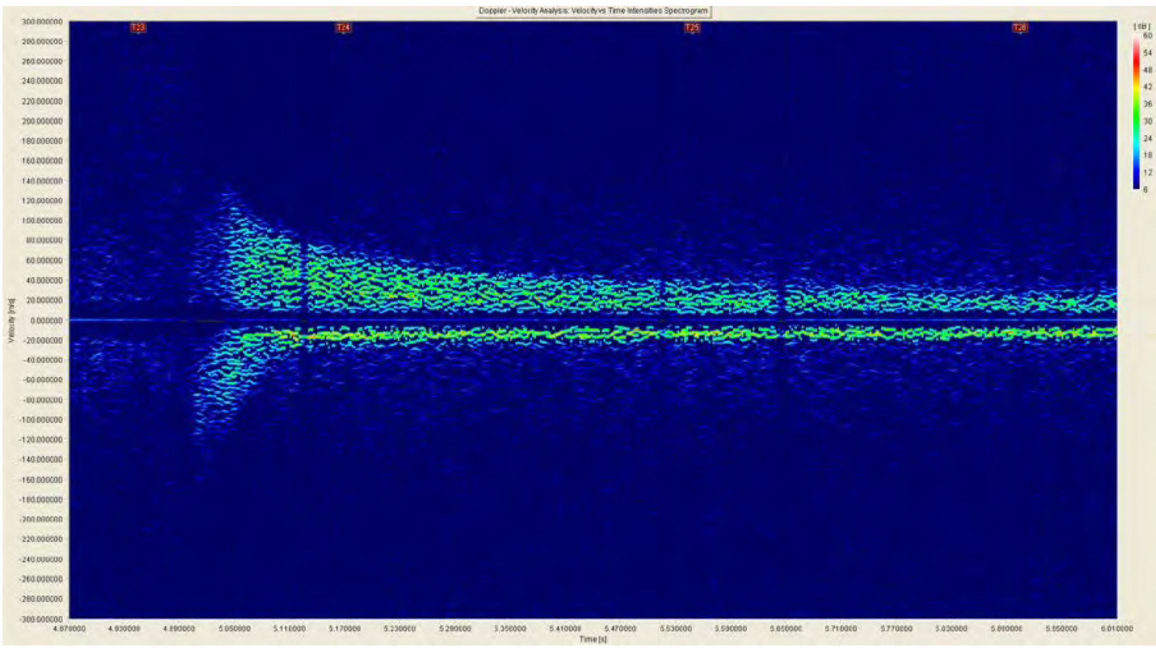

FIGURE III-31. Bunker 2K Intensity Profile for Test 2.

STRUCTURAL DEBRIS FRAGMENT MAPPING

When the structure ruptured, many debris fragments were produced and projected outward. The area around the ruptured structure was searched for the fragments with over 2,500 fragments found. When a fragment was found it was assigned a number and the GPS coordinates of the location were recorded. The debris samples were weighed, the color (black concrete indicated that the fragment came from the roof, grey from the north wall, yellow the east wall, red the south wall and green the west wall) was recorded, and if a photograph was taken the photograph number was also noted. If the debris was a piece of rebar or a piece of concrete having two colors indicating intersection of walls or roof and wall, that was also noted in the comments column. These data are presented in Table III-G-1 of Appendix G.

The data from Table III-G-1, Appendix G were grouped into the weight categories presented below. The distribution of number of fragments by weight grouping is shown in Figure III-32. Some of the fragments less than 200 grams were not recorded.

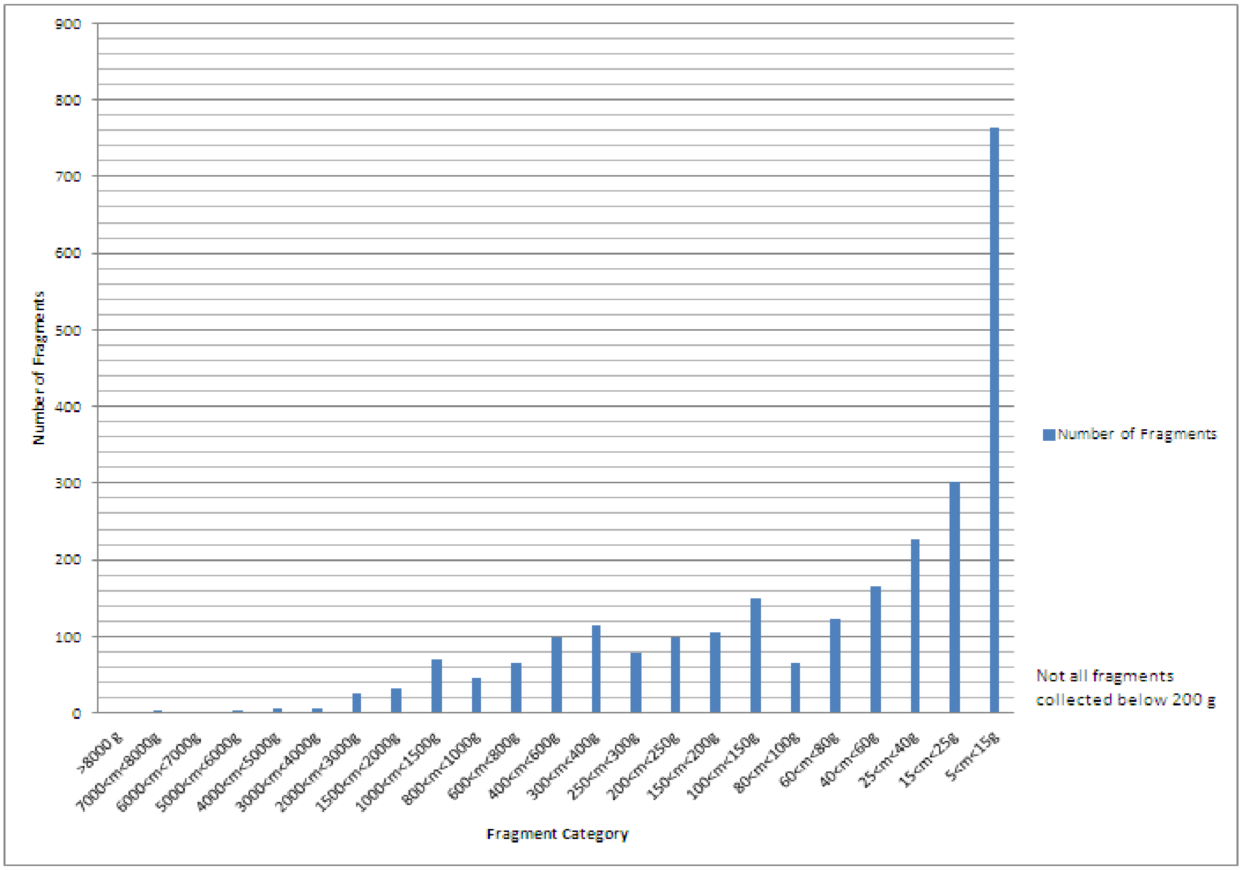

FIGURE III-32. Number Distribution of Fragments by Weight Categories (Test 2).

While there were many small fragments (e.g., there were more than 750 fragments in the 5<m<15-g category), the total mass for a category is relatively small when compared to the large fragments. For example, the total weight for the 750 fragments in the greater than 5<m<15-g range that were cataloged was 7,476 grams as compared to 8,400 grams for the largest fragment found.

Figure III-33 shows the total weight distribution of the fragments by the same fragment categories previously presented in Figure III-32 for the number distributions. Comparison of Figures III-32 and III-33 clearly shows that while the number density favors the smaller fragments, the weight density clearly favors the fragments in the 300<m<3,000-g range. Of the recovered fragments, the largest fragment by itself had more total mass than all of the fragments having less than 15 grams of mass (not all of the >200-g fragments were weighed).

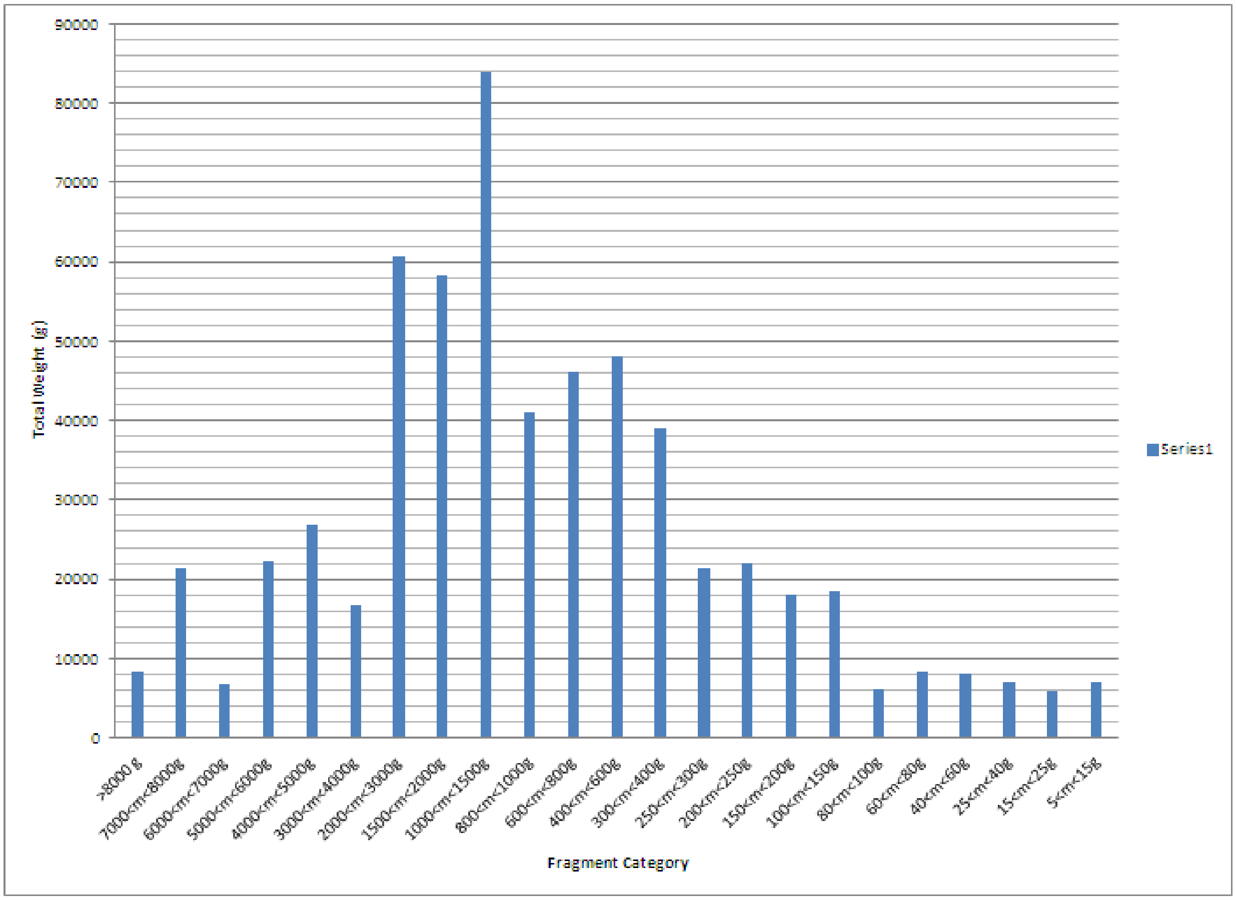

FIGURE III-33. Total Weight Distribution by Fragment Category (Test 2).

Figure III-34 presents the overall mapping of the recovered fragments for Test 2.

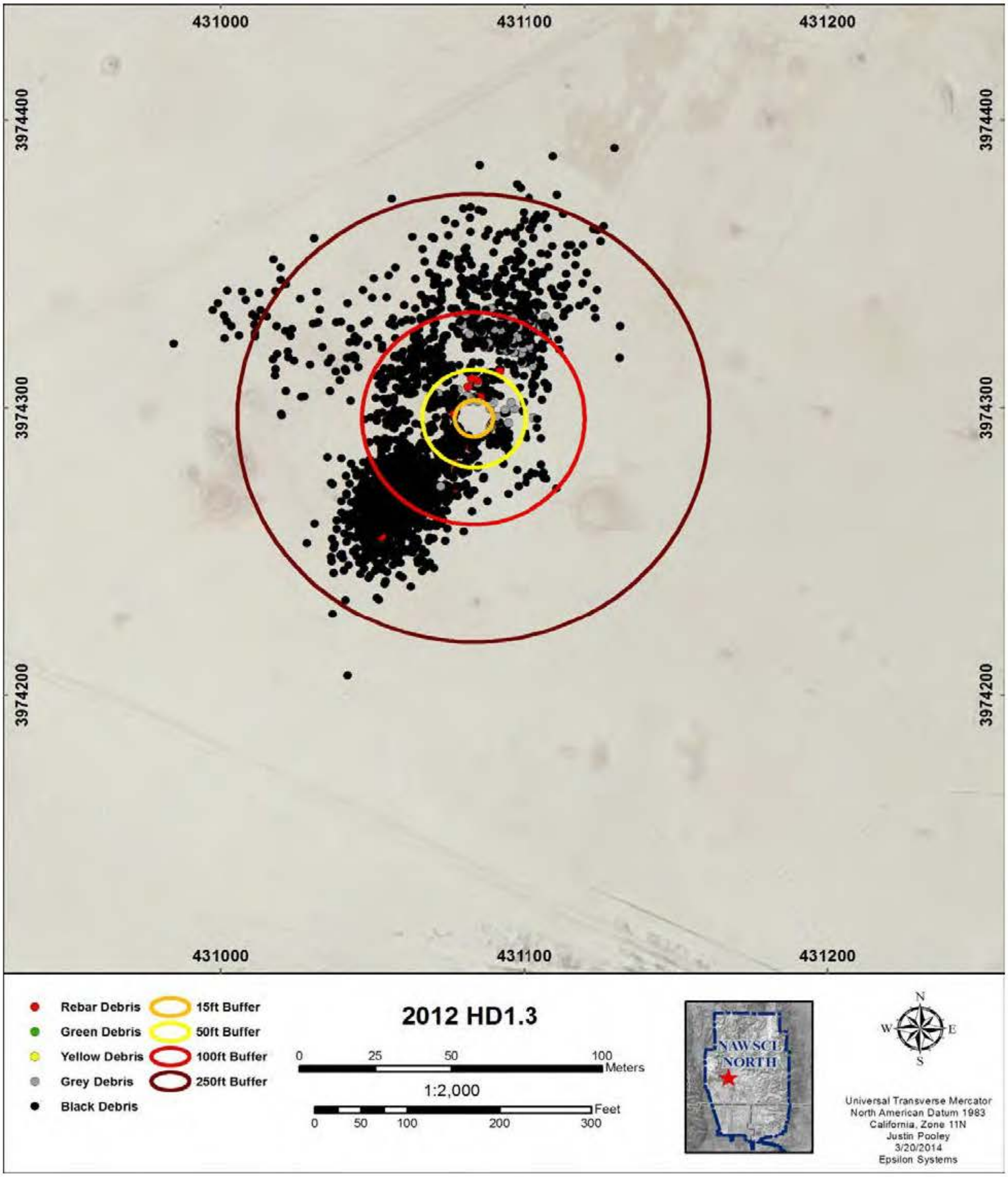

FIGURE III-34. Fragment Map From Test 2 Conducted on 15 December 2012.

The fragment map shows that most of the fragments were from the roof (black concrete). The map presented in Figure III-34 is a bit misleading. Some of the fragments are not shown because of the following:

- Fragments weighing less than 5 grams were intentionally not picked up, weighed, or cataloged.
- Fragments thought to weigh 200 grams or less, in the western and southern areas, within the 70-foot radius from the center of the original structure were not weighed due adverse weather. The extremely high and gusting winds sometimes resulted in plus or minus 100-gram excursions during the weighing of individual small fragments using the platform balance, preventing the accurate weight recording of fragments smaller than 200 grams. These large excursions would have comprised the values, however, because these locations were essentially in the “near field,” a decision was made not to record the weights of these small fragments.

The structural debris was obviously projected significant distance from the original structure. For example, the northernmost fragment weighed 76 grams and was found 105 meters (341 feet) from the center of the original structure. In addition, the westernmost fragment weighed 422 grams and was found approximately 100 meters (328 feet) from the center of the original structure. Finally, the southernmost fragment weighed 18.1 grams and was found approximately 95 meters (312 feet) from the center of the original structure.

Figure III-35 shows the location of the largest fragment (red data point) found in Test 2. This fragment weighed 8,400 grams. The fragment location (Figure III-35) corresponds to a distance 37 meters (121.4 feet) from the center of the original structure.

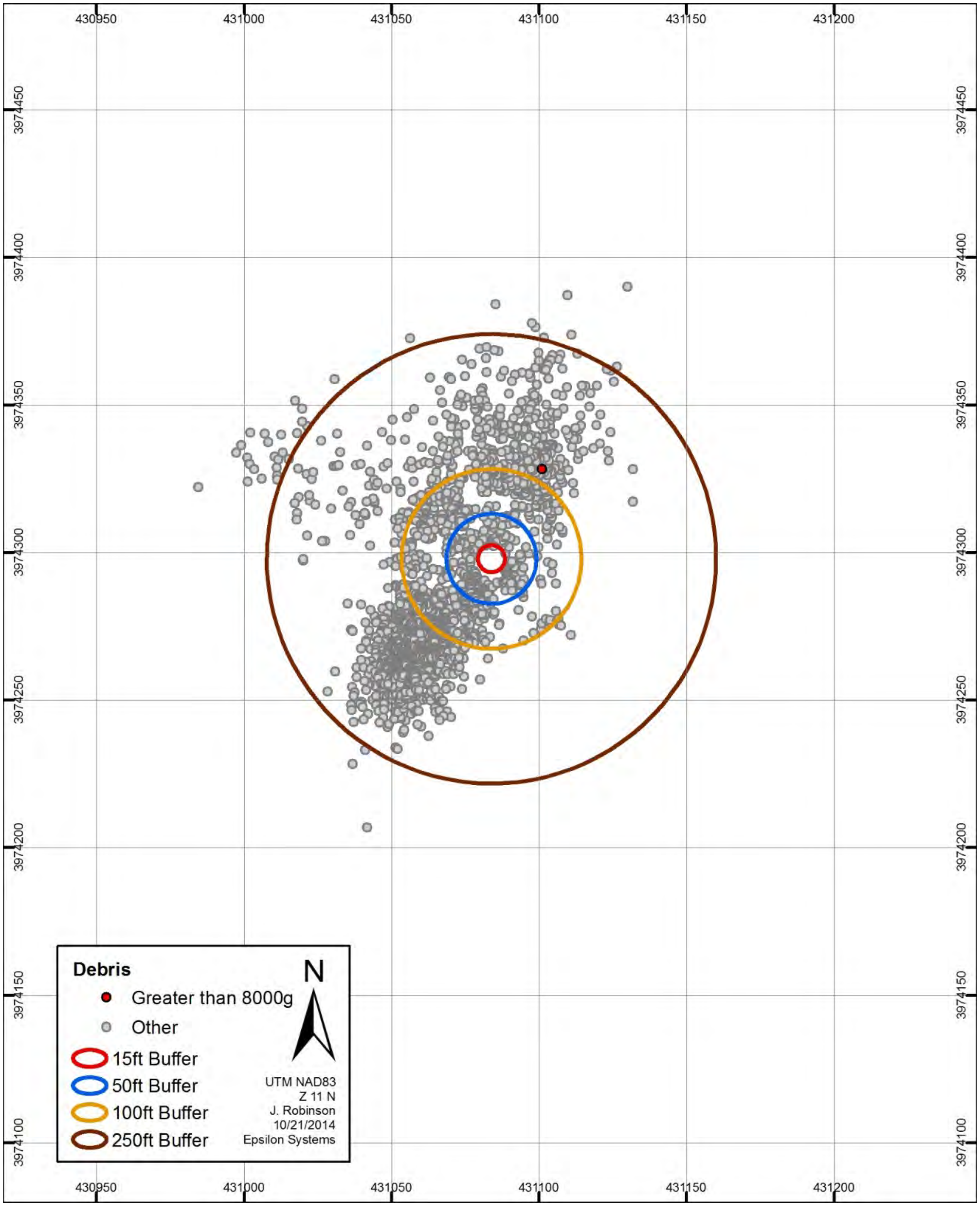

FIGURE III-35. Location Where Largest Fragment (8,400 g) Was Found (Test 2) Approximately 37 Meters From Center of Original Structure.

Figure III-36 shows a photograph of this very large fragment. This fragment was black concrete under the white coating, indicating that it came from the roof of the structure. The fragment in question was an edge piece adjacent to the north wall.

FIGURE III-36. Photograph of Largest Fragment (8,400 g)
With Location Coordinates (Test 2).

This fragment was interesting, not only because it was the largest fragment found but because the authors were able to find fragments that had been adjacent to this fragment in the original structure (Figure III-37). The largest fragment (8,400 g) is on the left in Figure III-37. All of these fragments were black concrete with the squared edge, indicating that they were originally the north edge of the roof.

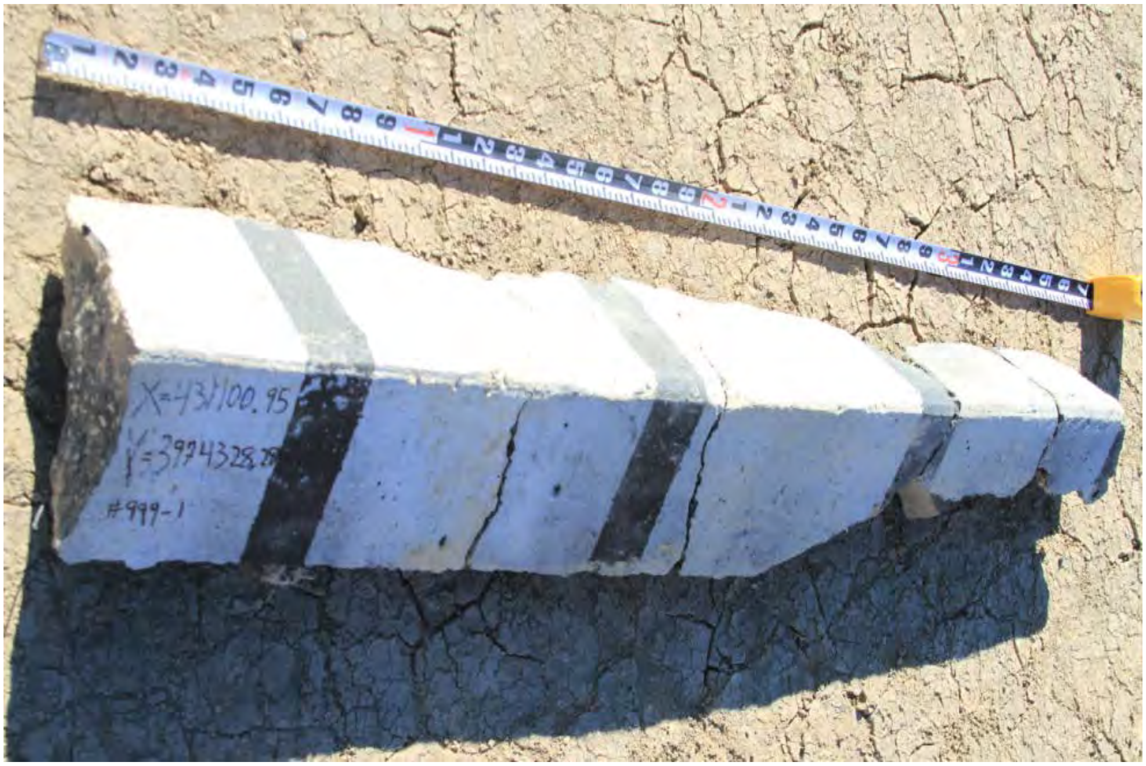

FIGURE III-37. Fragments Originally Adjacent to One Another in Undamaged Structure (Test 2). The largest fragment shown in Figure III-36 appears on the left in this figure.

Appendix III-G has the fragment maps for each of the weight categories as well as photographs of the larger debris fragments.

Figure III-38 shows a single fragment that weighed 6,665 g. This fragment was found only 6.4 meters from the center of the original structure. The gray color of the concrete indicates that this fragment came from the north wall. The very distinct impression of the rebar with the raised ribs is shown, indicating that the concrete surrounding the rebar had fractured releasing the rebar rather than the rebar being pulled through the concrete. Rebar being pulled through the concrete would have obliterated the rib indentations in the concrete. Fragments depicted in Figures III-39 and III-40 show evidence of both types of failure as indicated by the call outs. While both types of failure are shown, most of the fragments displayed the concrete fracturing from around the rebar, rather than the rebar being pulled through the concrete.

FIGURE III-38. Fragment Weighing 6,665 g
Found Northwest of Structure (Test 2).

FIGURE III-39. Debris Fragment Weighing 2,605 g.
This debris fragment shows both types of failure: rebar pulled through concrete obliterating the rib pattern (left) and fracture of the concrete from around the rebar preserving the rib pattern of the rebar.

FIGURE III-40. Fragment Weighing 1,485 g From North Wall.
Evidence of rebar pulled through the concrete during rupture,
as well as concrete that was fractured around rebar
exposing pattern of rebar and ribs.

CONCLUSIONS AND RECOMMENDATIONS

Test 2 was the second of a series of tests designed to examine the effect of an HD1.3 energetic material burning in a concrete structure. M1 propellant was the test sample. Test 2 was performed with a 39-cm-diameter orifice in the faceplate of the structure, resulting in a vent area ratio of 0.0299. The smaller vent area and increased propellant loading density (66.68 kg/m^3) resulted in a choked venting condition with increasing pressure leading to structural failure.

Structural failure occurred 1.401 to 1.410 seconds after application of current to the ignition train (determined by IRIG timing) at internal pressures measured at 44 and 54 psi. The roof bulged due to pressure and failed beginning at the roof-north wall intersection, peeled back, and what was left of the roof came to rest against the exterior of the south wall. While the roof was peeling back, many fragments were formed and projected to some distance from the structure. The metal structure and the attached

faceplate became detached from the north wall, beginning approximately 624 microseconds after the rupture of the roof. The frame and orifice plate were at approximately 45 degrees from vertical 0.1 second after the roof started to rupture. During this time, large fragments were formed and projected from the roof. Appendix III-D contains the detailed timeline of events taken from the high-speed videos taken during the test.

As shown in the fragment map presented in Figure III-32, there were many fragments found at distances 100 feet (30.5 meters) and greater from the center of the original structure. Many fragments greater than 5 grams were recovered at distances beyond 250 feet (76.2 meters). The largest recovered fragment was 8,400 grams located 37 meters (121 feet) from the structure. The majority of the fragments generated in Test 2 were from the roof of the structure. This failure mechanism is probably due to the construction of the structure as mentioned in Chapter I of this document. Therefore, the recommendation is that the test be repeated with increased rebar attachment in the structure, especially at intersections of walls and intersections of the walls with the roof.

The calculated inhabited building distance (IBD) or public traffic route distance (PTRD) for this test was 76.41 feet and the calculated intermagazine distance (IMD) or intraline distance (ILD) was calculated to be 51.83 feet (Reference III-1). Over 2,609 fragments were created by the failing structure. A total of 38 of those fragments landed beyond the calculated IBD/PTRD, while 279 fragments landed beyond the calculated IMD/ILD. Of these fragments, 94% weighed greater than 5 g. Using the charts in Reference III-3, these fragments would produce more energy than the maximum 79-joule limit.

The velocity of the plume was determined using the Doppler data. The plume was detected at 5.4 seconds reaching a maximum velocity of 138 m/s before retreating into the structure.

The maximum temperature (164.66°C) observed outside of the structure was at approximately 32 feet. Several gage locations experienced temperatures above 50°C for up to 156.69 seconds (2.61 minutes). The maximum flux observed within the plume was 913.31 kW/m^2. Beyond the calculated IBD/PRTD distance flux, was recorded at 17.98 kW/m^2 and at 325.17 feet, the flux reached 4.27 kW/m^2. The calculated time to injury (1st degree burns) is between 2.94 seconds at 158.08 feet from the event, using the flux formulation from the (Reference III-1). The American Petroleum Institute estimates that a reaction time of 3 to 5 seconds followed by an additional 5 seconds is needed for an individual to respond to a threat (i.e., a total of 8 to 10 seconds are needed to respond to a thermal threat) (Reference III-2).

REFERENCES

III-1. Office of the Deputy Under Secretary of Defense (Installations and Environment). *DOD Ammunition and Explosives Safety Standards.* Washington, D.C., USD(I&E), 29 February 2008. Administratively Reissued 4 August 2010. (DODM 6055.09-M, Volume 1, Enclosures 8 and 9; publication UNCLASSIFIED.)

III-2. American Petroleum Institute. "Guide for Pressure-Relieving and Depressurizing Systems." Washington, D.C., American Petroleum Institute, 1997. (API 521.)

III-3. United Nations. "Guide for Pressure-Relieving and Depressurizing Systems," in *Recommendation on the Transportation of Dangerous Goods: Manual of Test and Criteria,* 4^{th} ed. New York, United Nations, 2005.

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Appendix III-A

HD1.3 TEST 2. PRESSURE DATA

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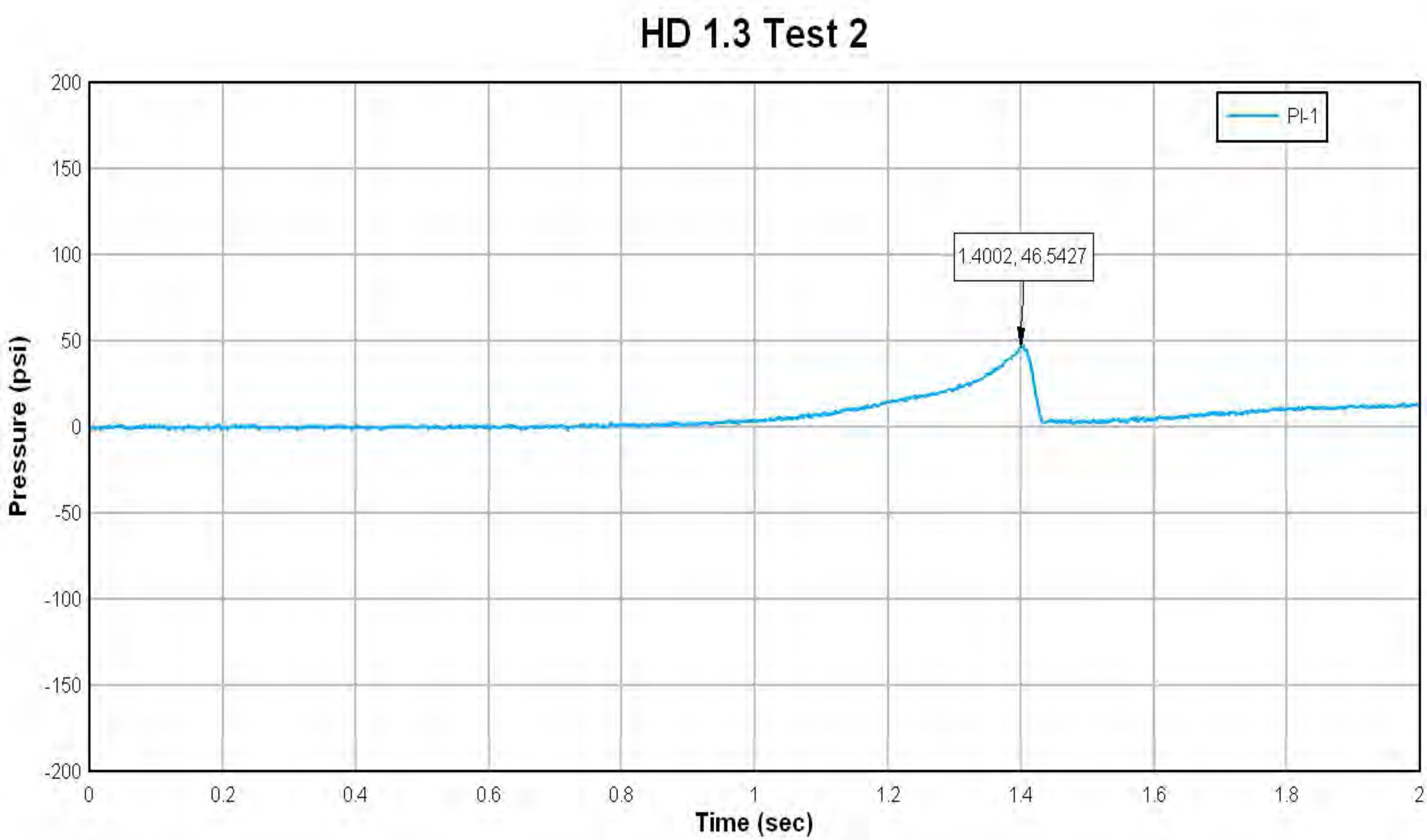

FIGURE III-A-1. Internal Pressure Gage #1.

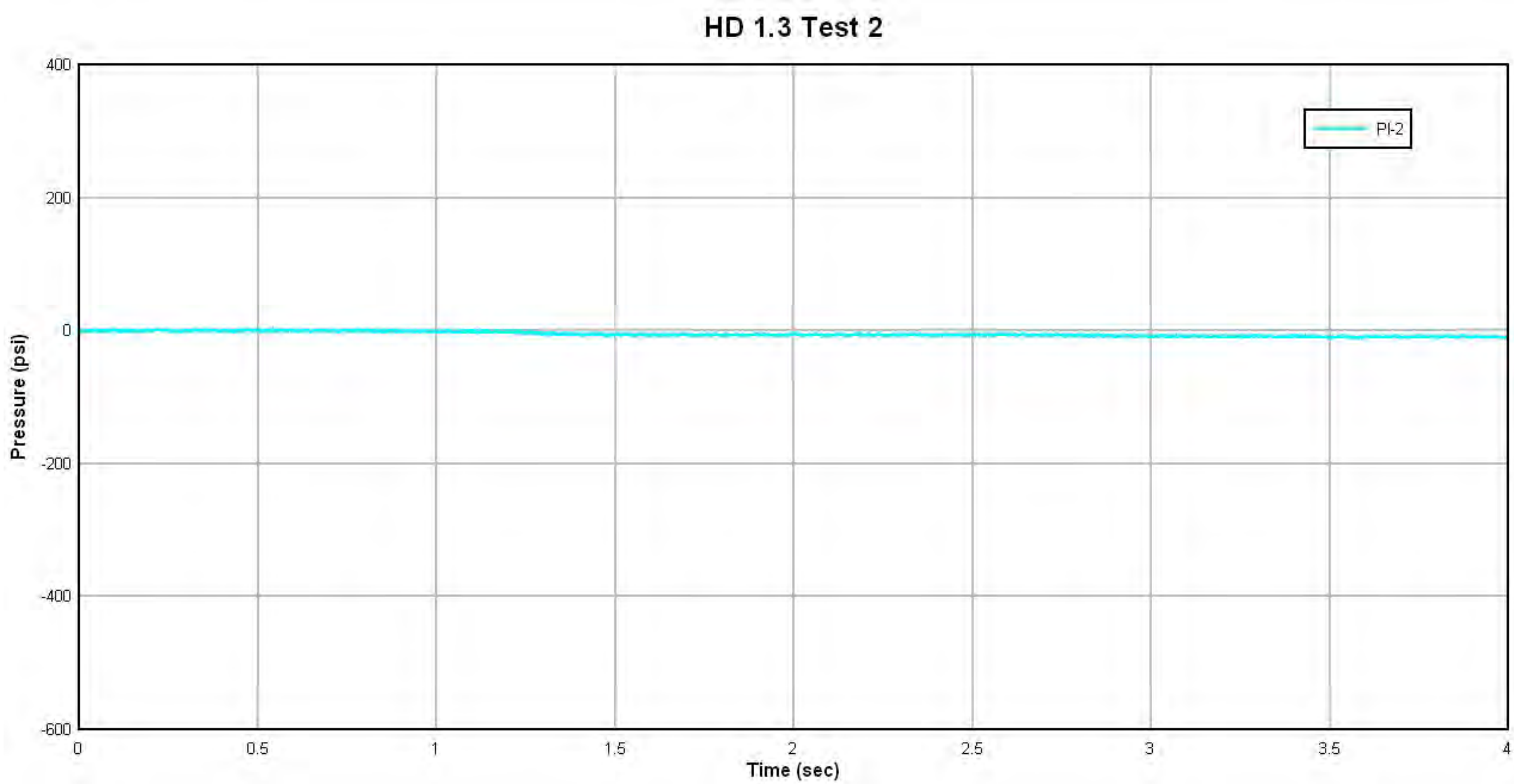

FIGURE III-A-2. Internal Pressure Gage #2.

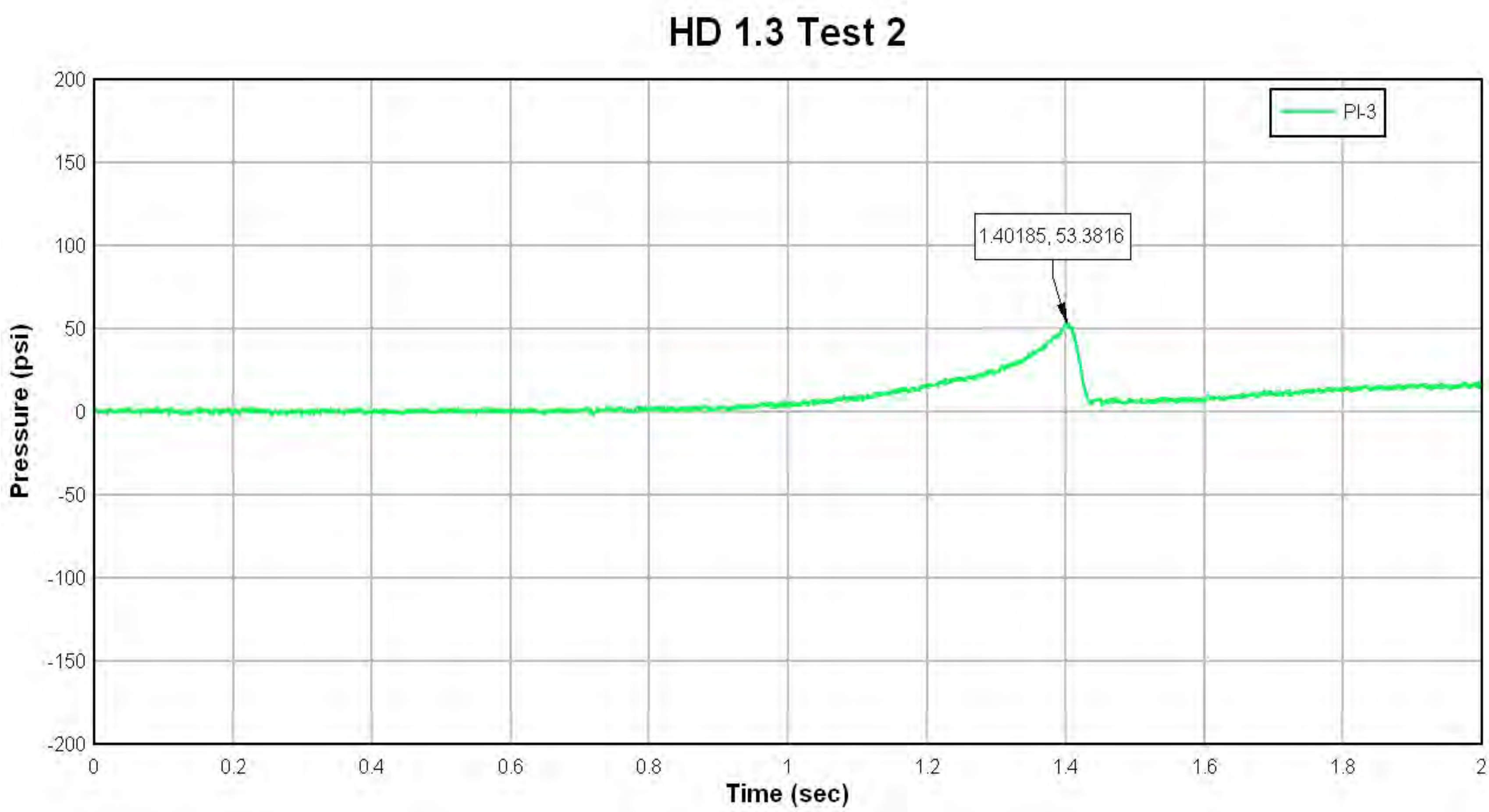

FIGURE III-A-3. Internal Pressure Gage #3.

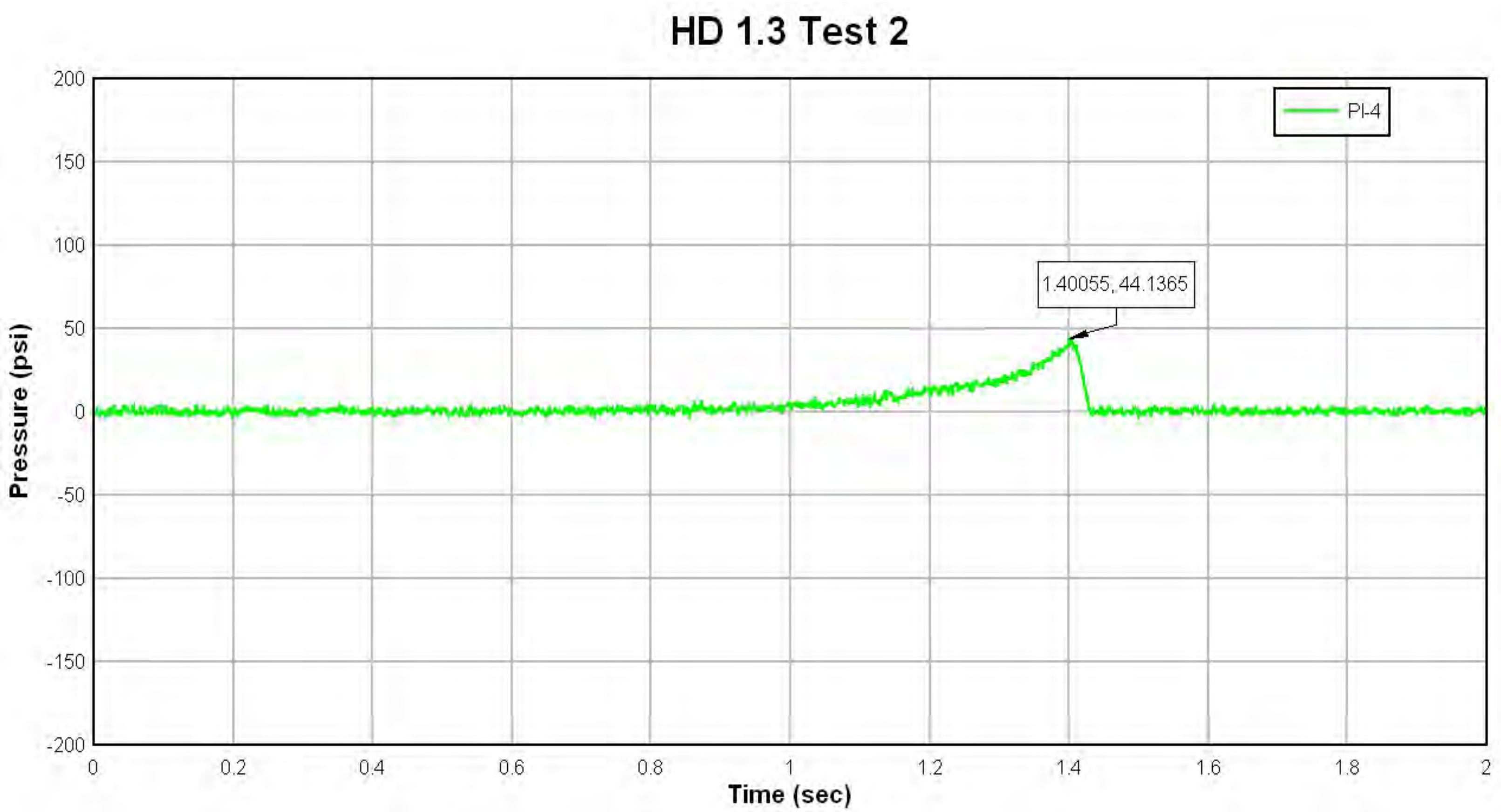

FIGURE III-A-4. Internal Pressure Gage #4.

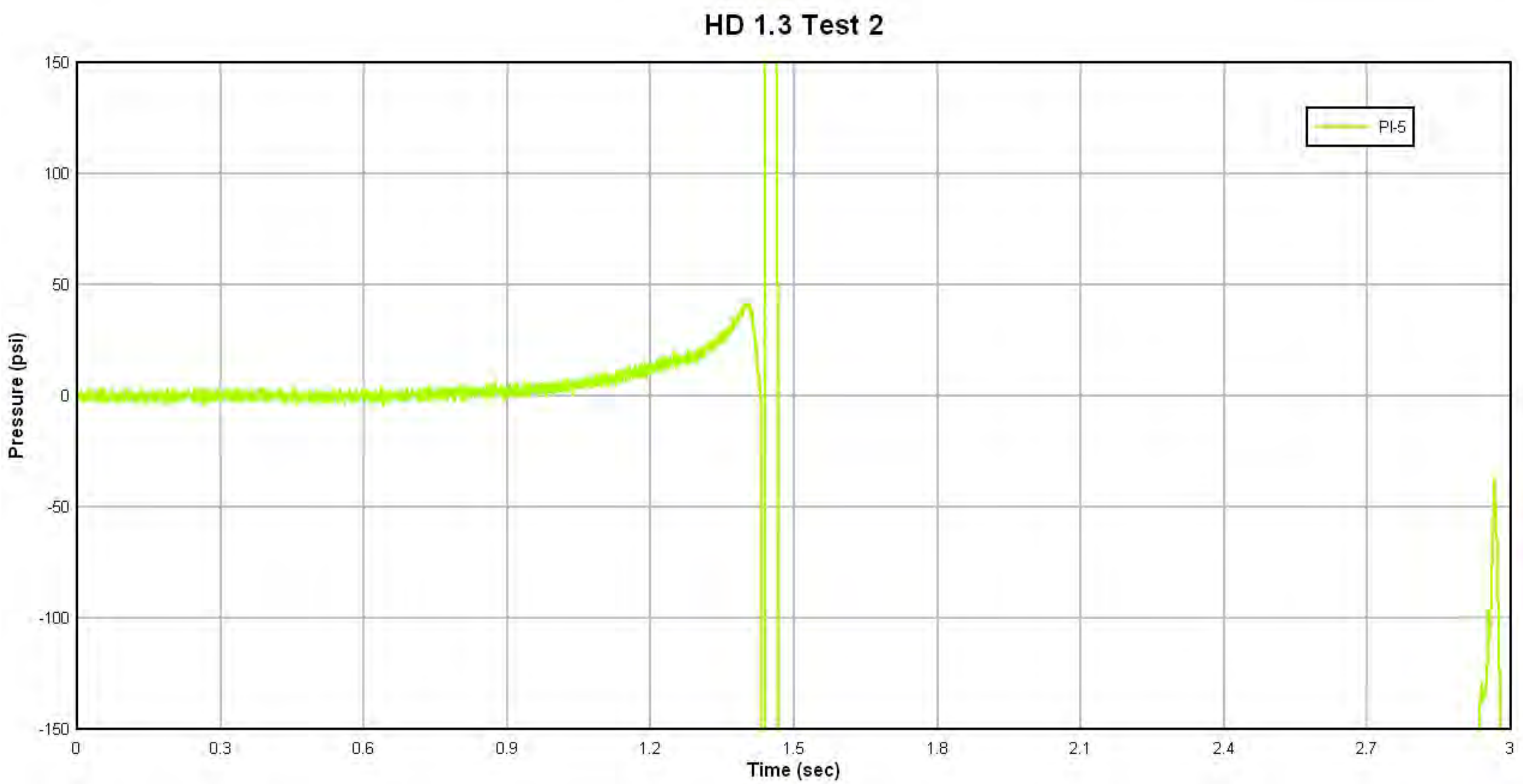

FIGURE III-A-5. Internal Pressure Gage #5.

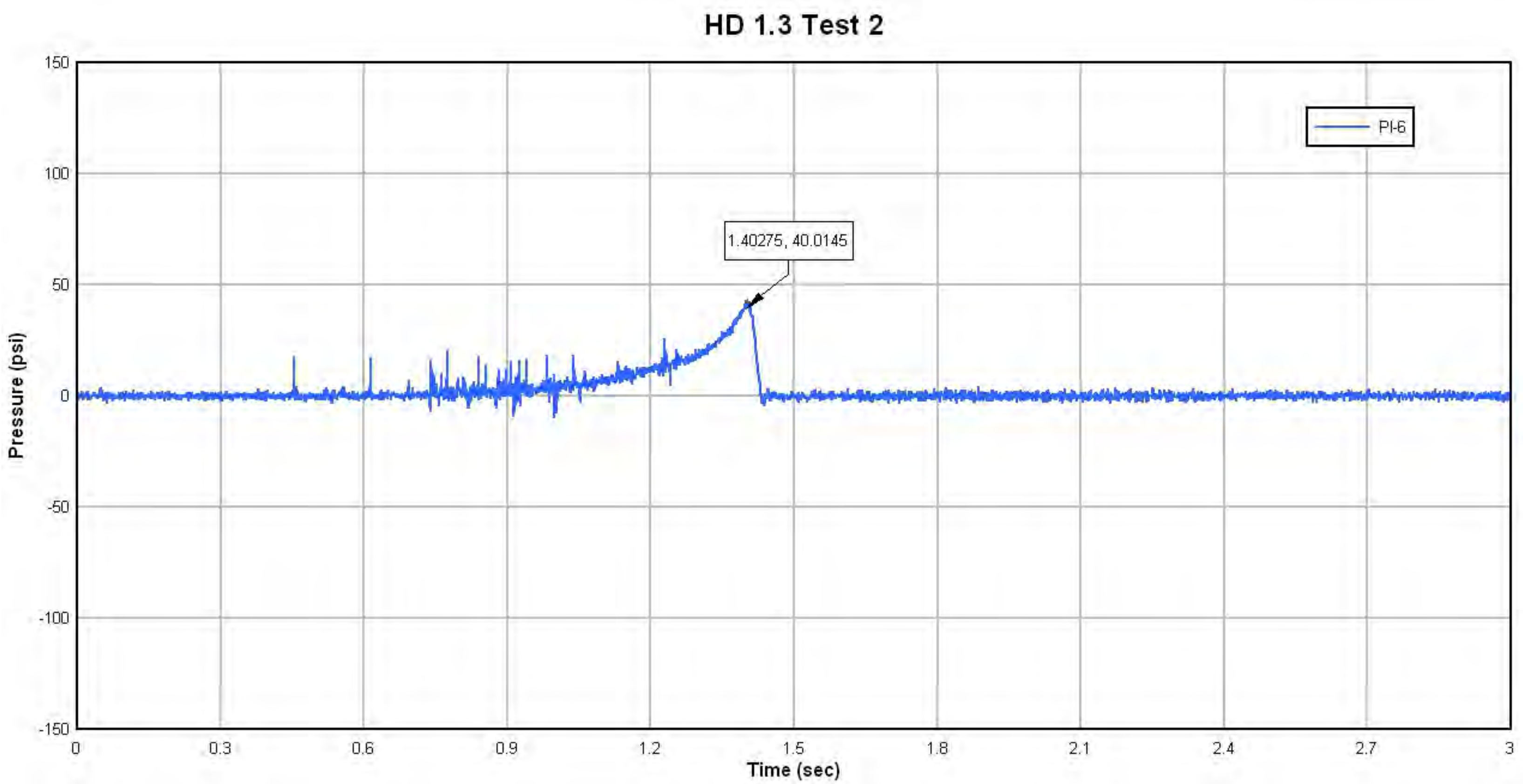

FIGURE III-A-6. Internal Pressure Gage #6.

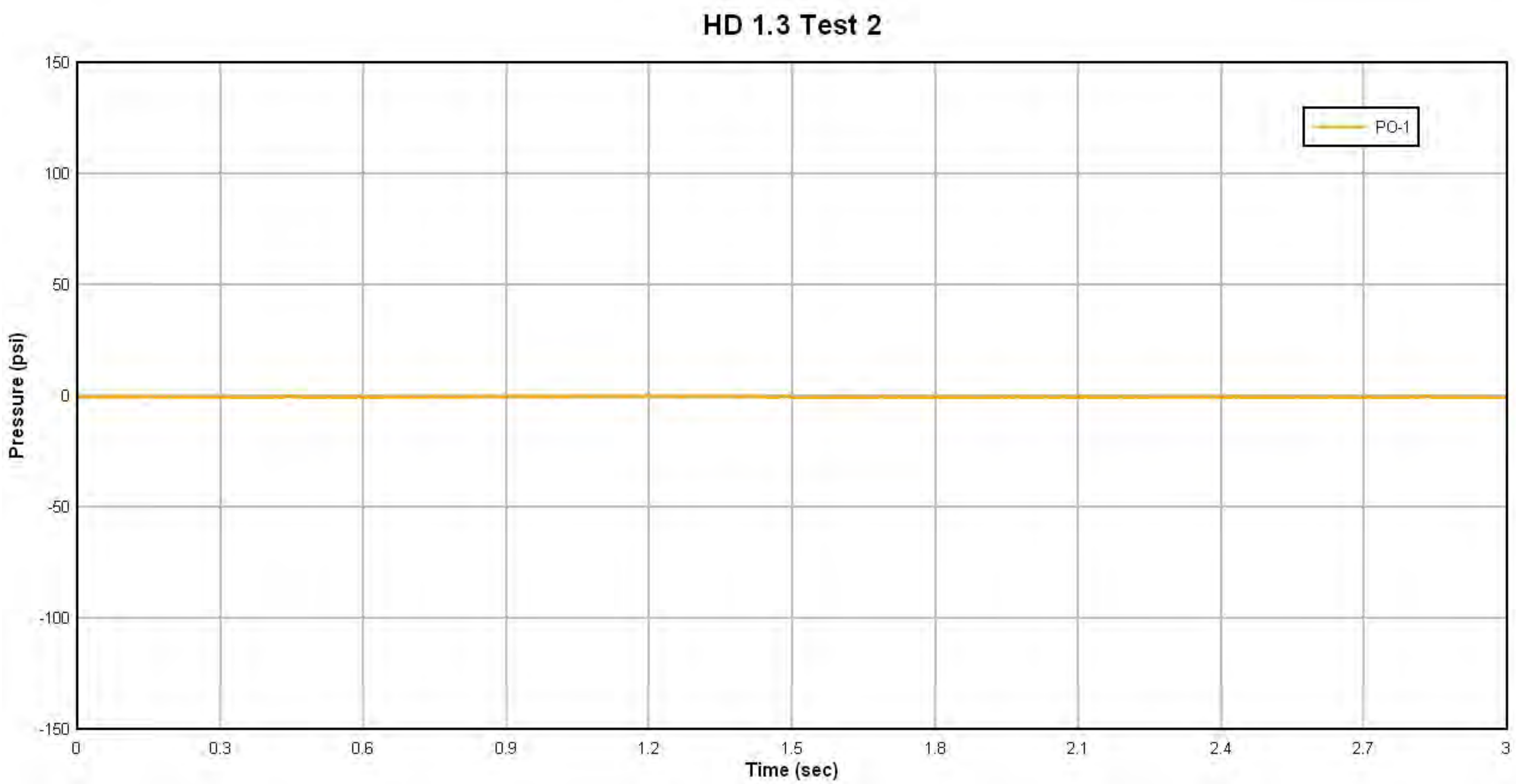

FIGURE III-A-7. External Pressure Gage #1.

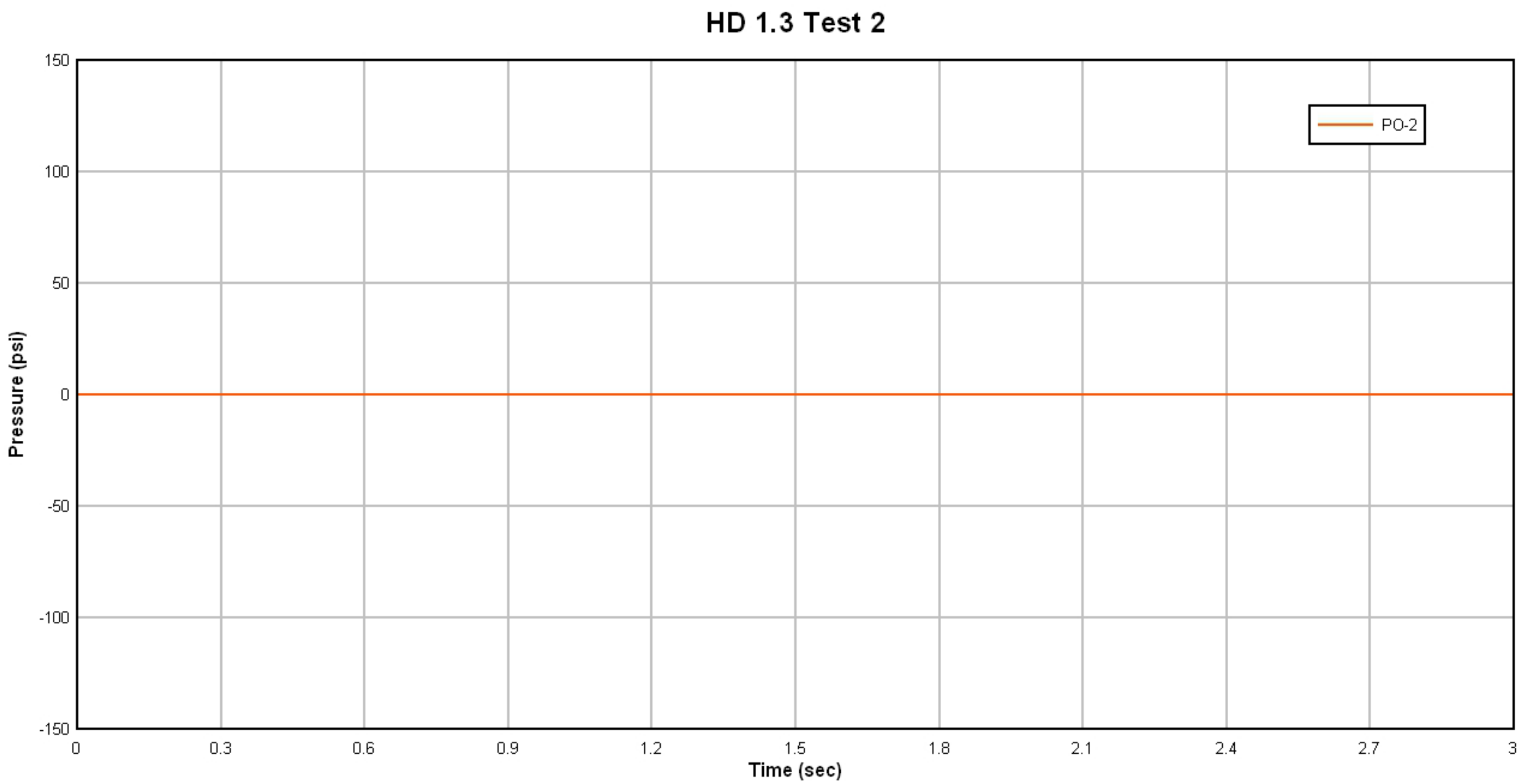

FIGURE III-A-8. External Pressure Gage #2.

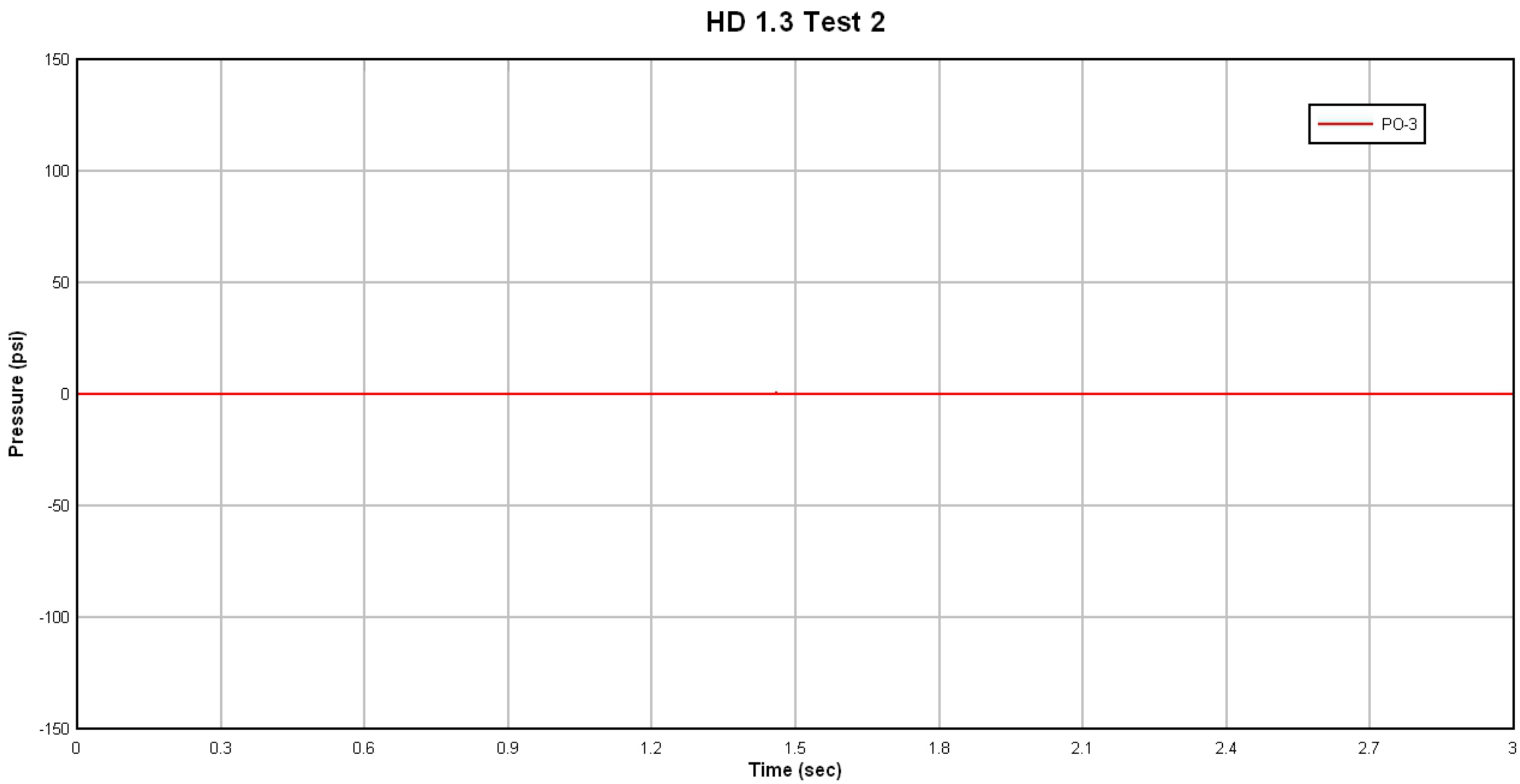

FIGURE III-A-9. External Pressure Gage #3.

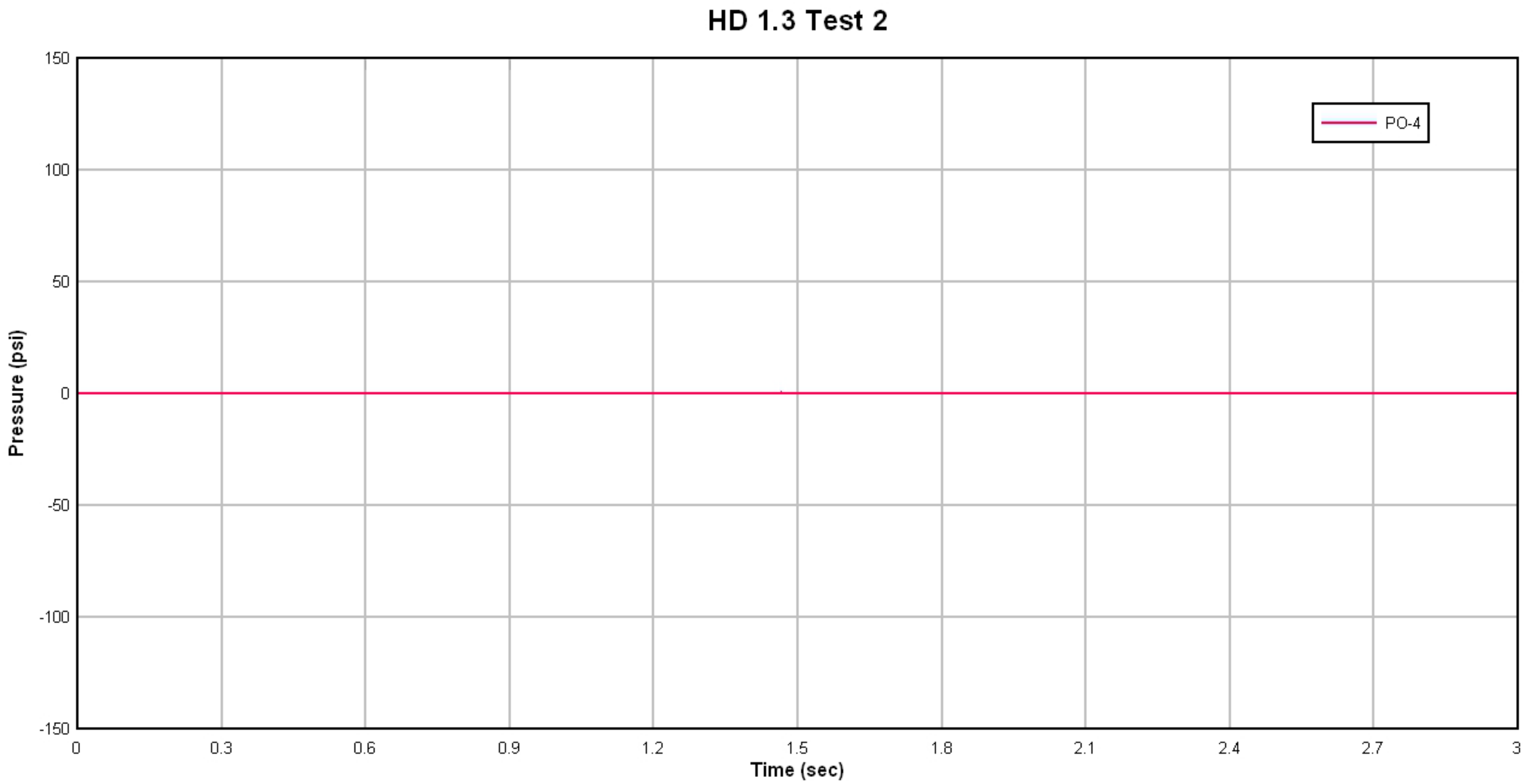

FIGURE III-A-10. External Pressure Gage #4.

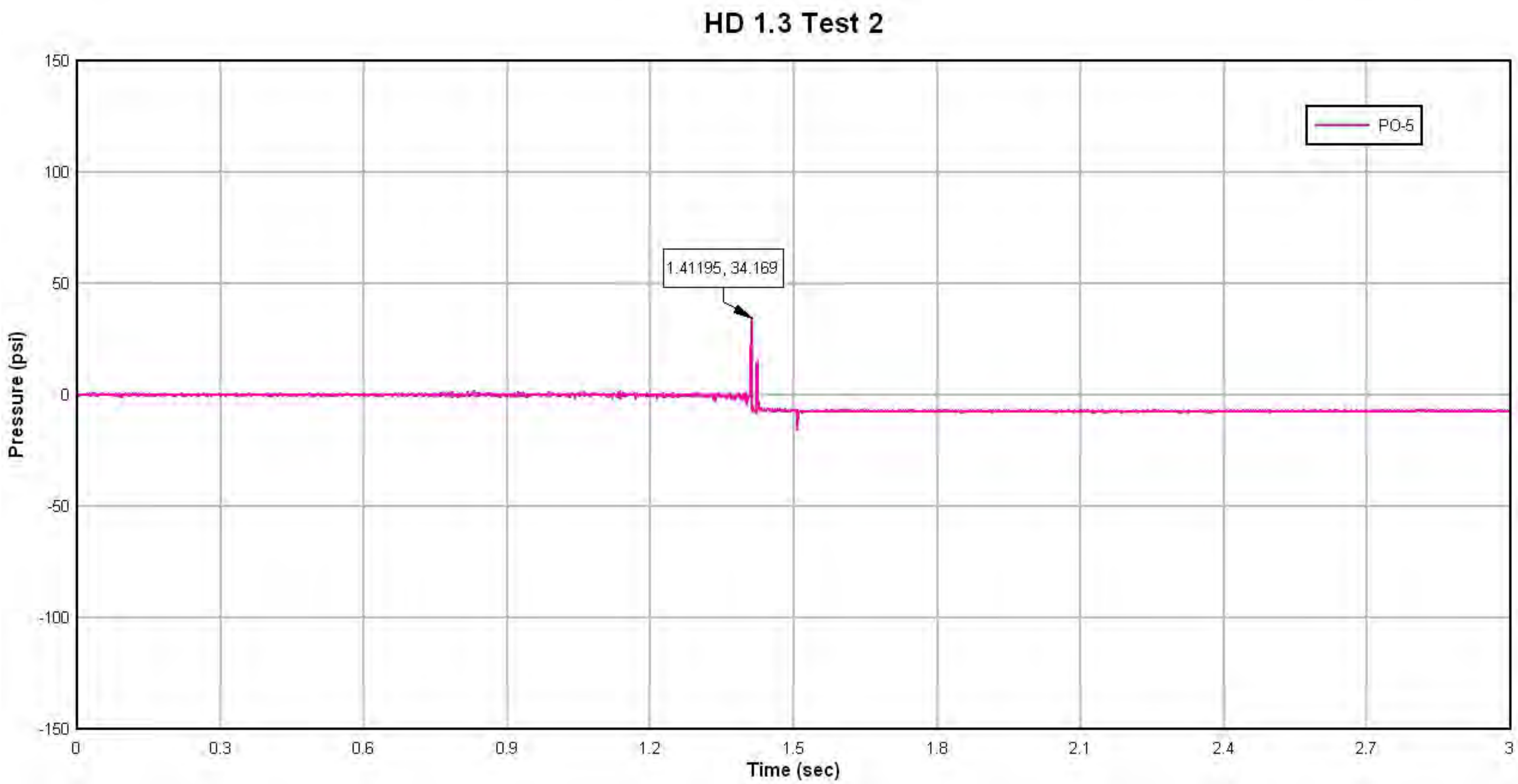

FIGURE III-A-11. External Pressure Gage #5.

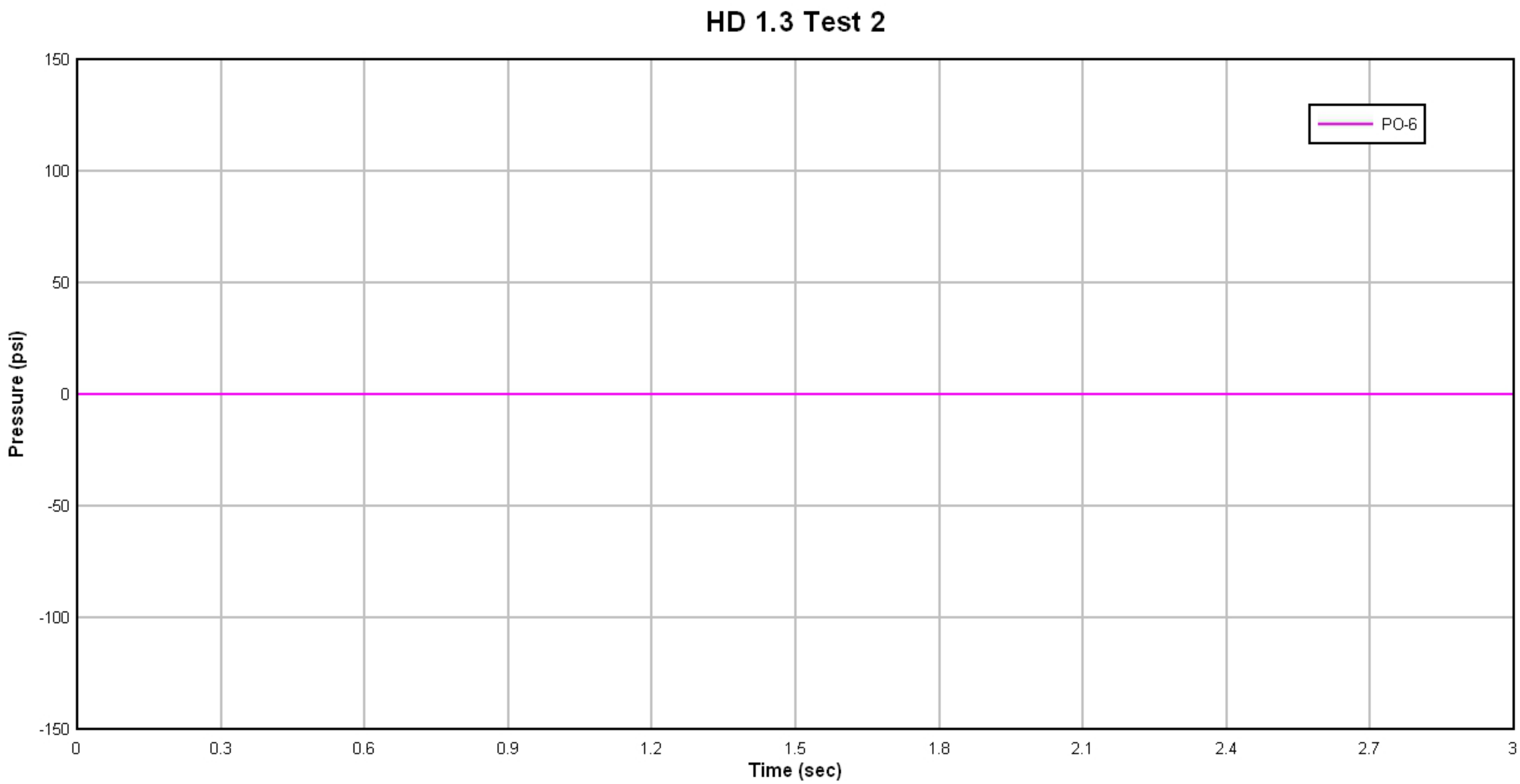

FIGURE III-A-12. External Pressure Gage #6.

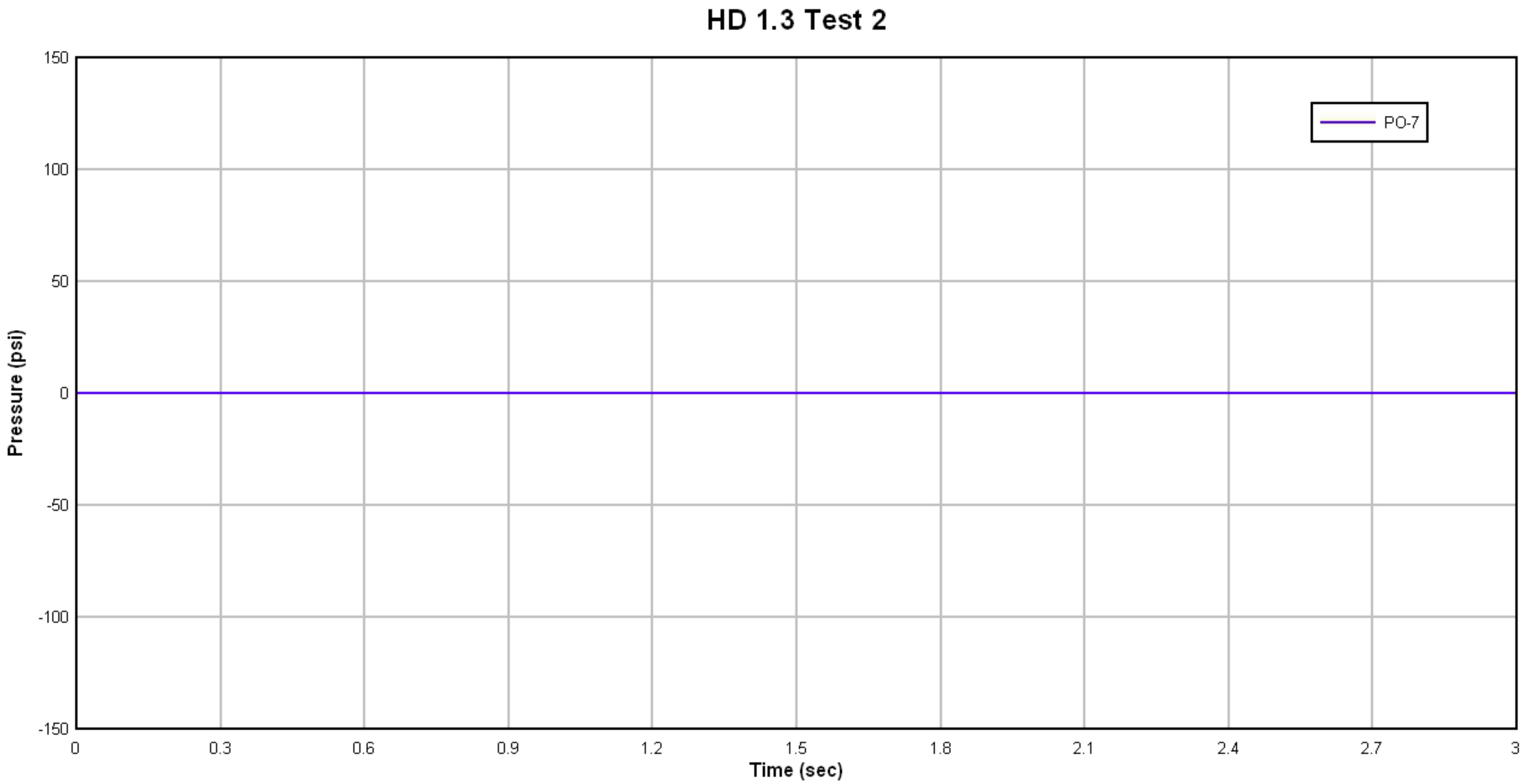

FIGURE III-A-13. External Pressure Gage #7.

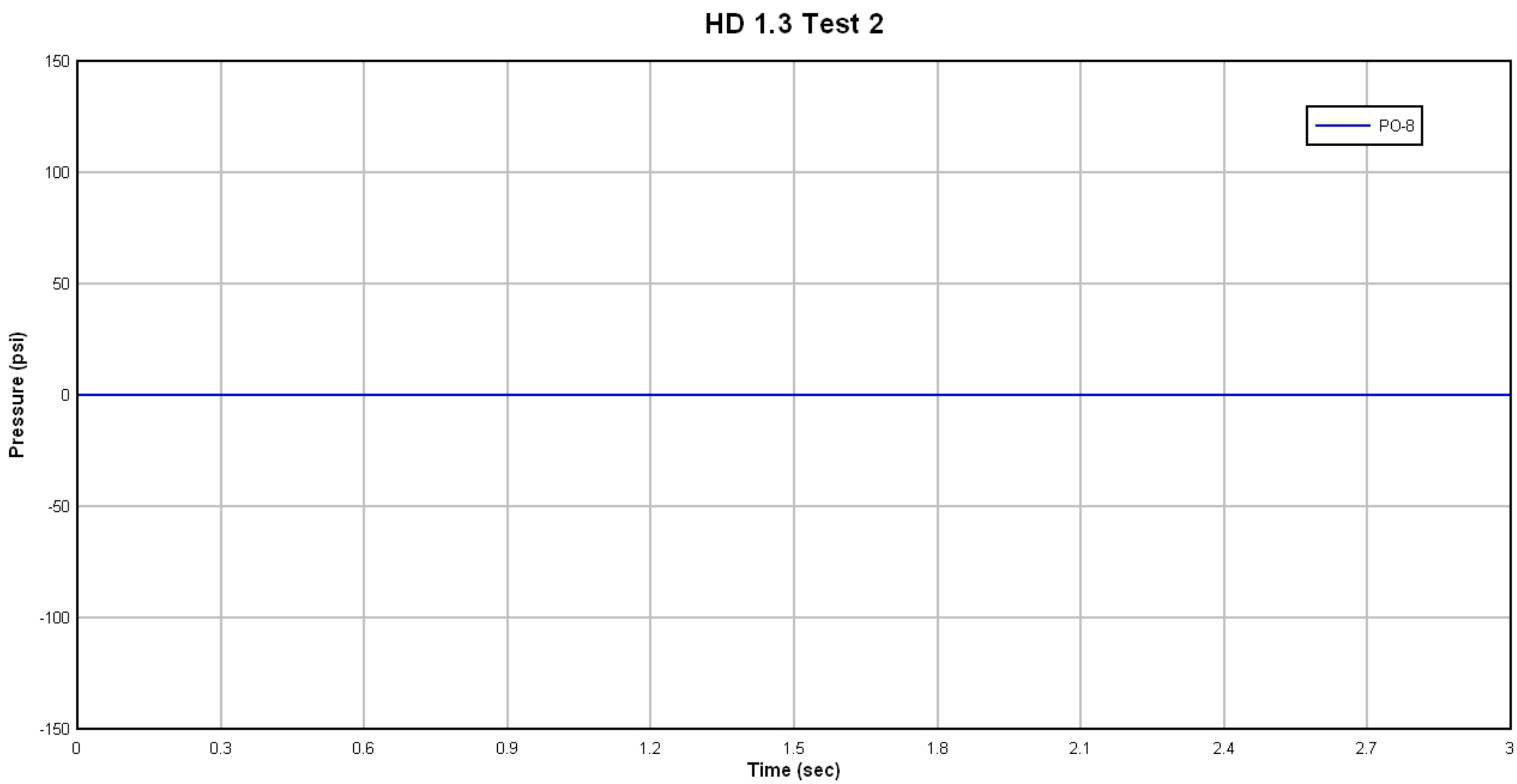

FIGURE III-A-14. External Pressure Gage #8.

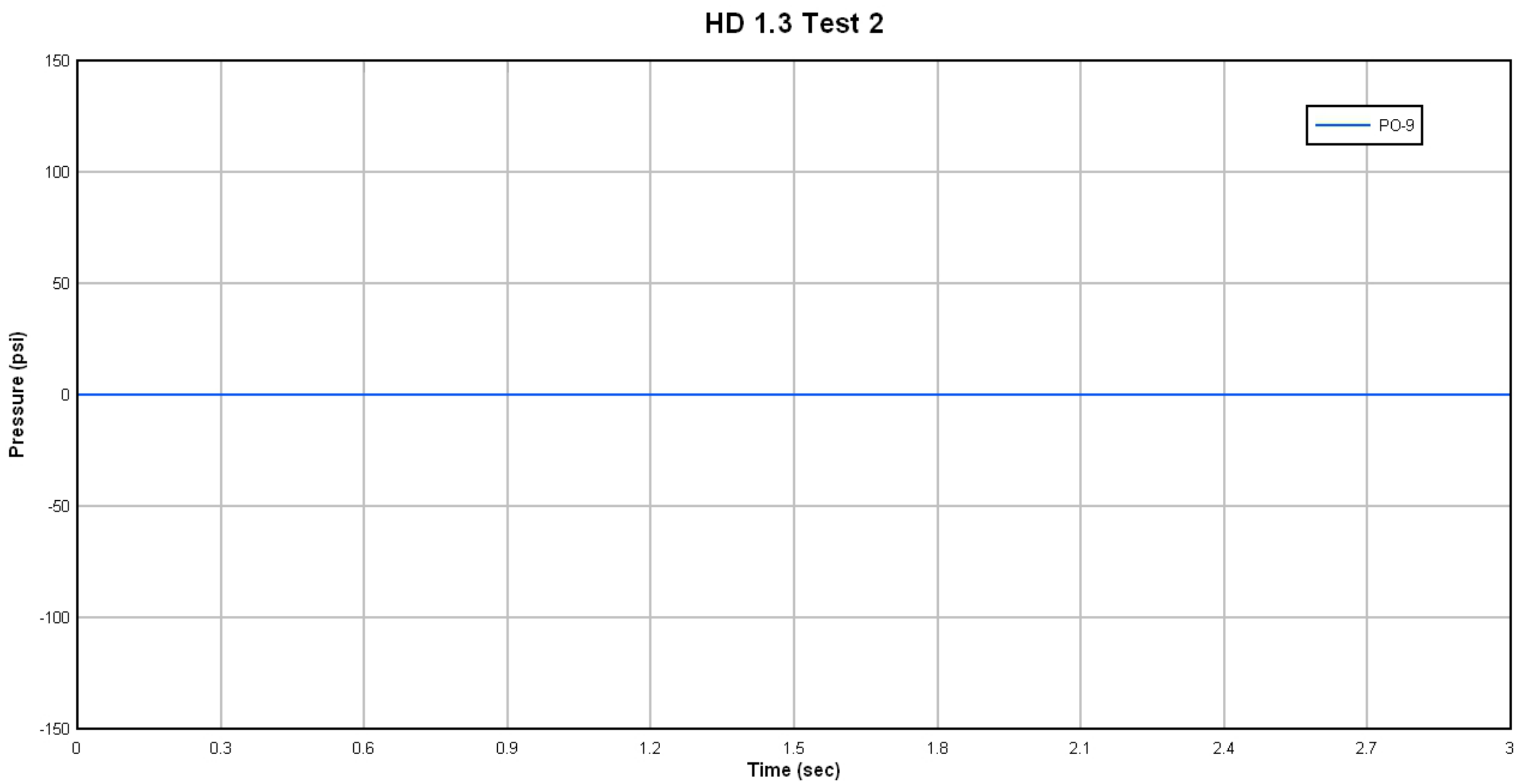

FIGURE III-A-15. External Pressure Gage #9.

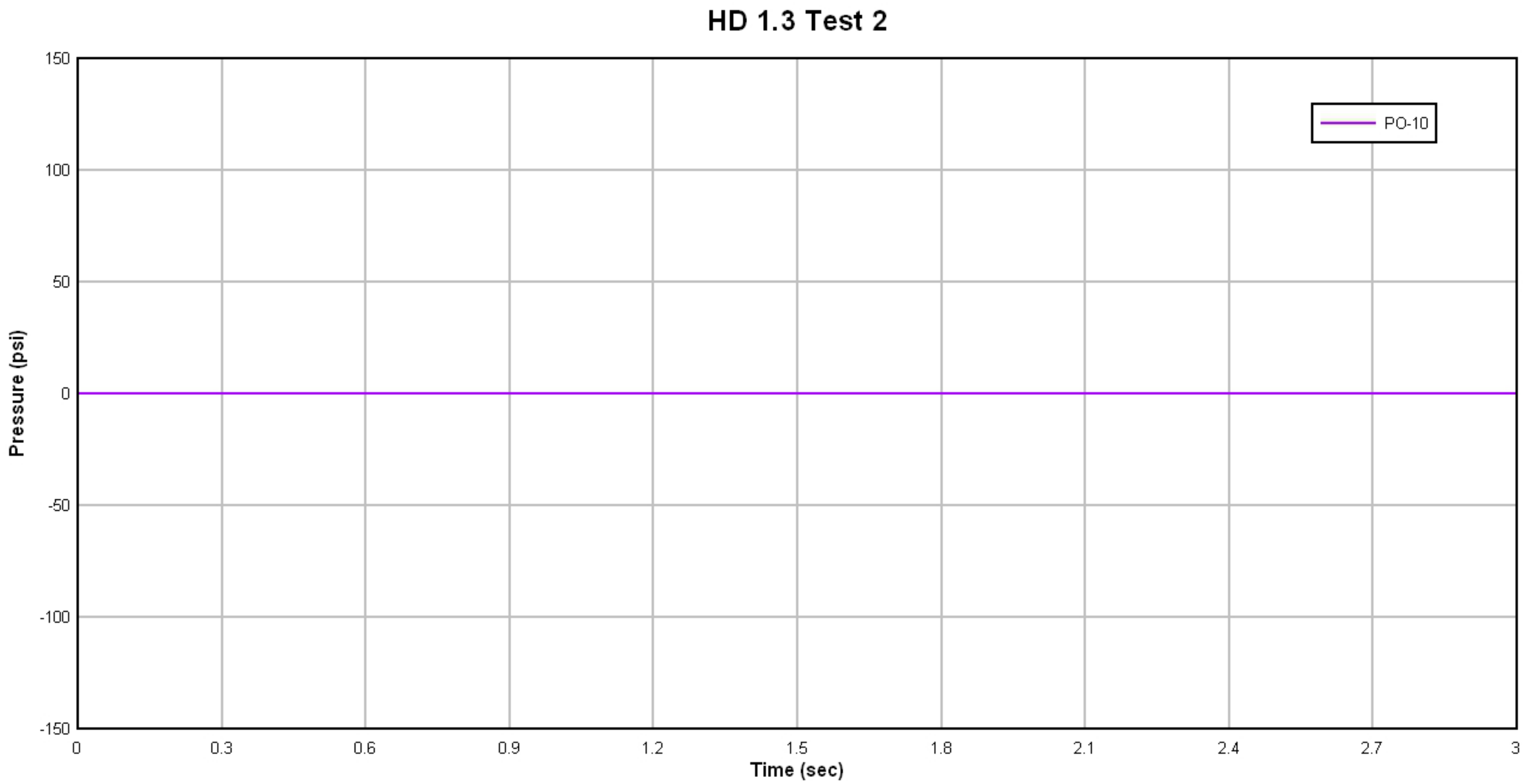

FIGURE III-A-16. External Pressure Gage #10.

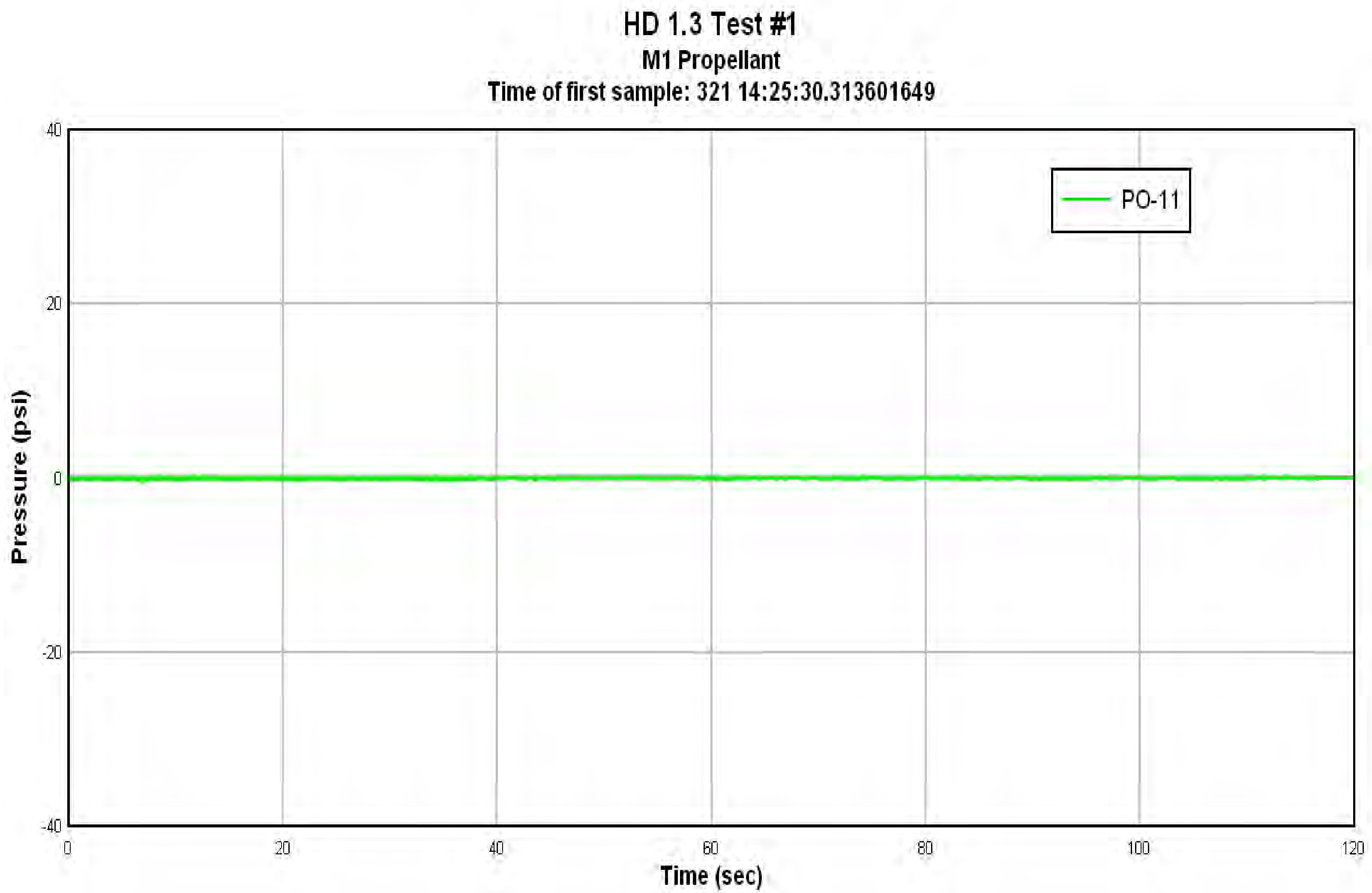

FIGURE III-A-17. External Pressure Gage #11.

SUMMARY

- Peak Internal Pressure 51.84 psi at Gage 3 at 1.39 sec
- Peak External Pressure 34.16 psi at Gage 5 at 1.4 seconds – Believed to be an effect of having the gage hit by a fragment

Appendix III-B

HD1.3 TEST 2. IR AND HIGH-SPEED CAMERA COVERAGE

(See DVD for Appendix III-B IR and High-Speed Video)

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Appendix III-C

HD1.3 TEST 2. TEMPERATURE AND THERMAL FLUX DATA

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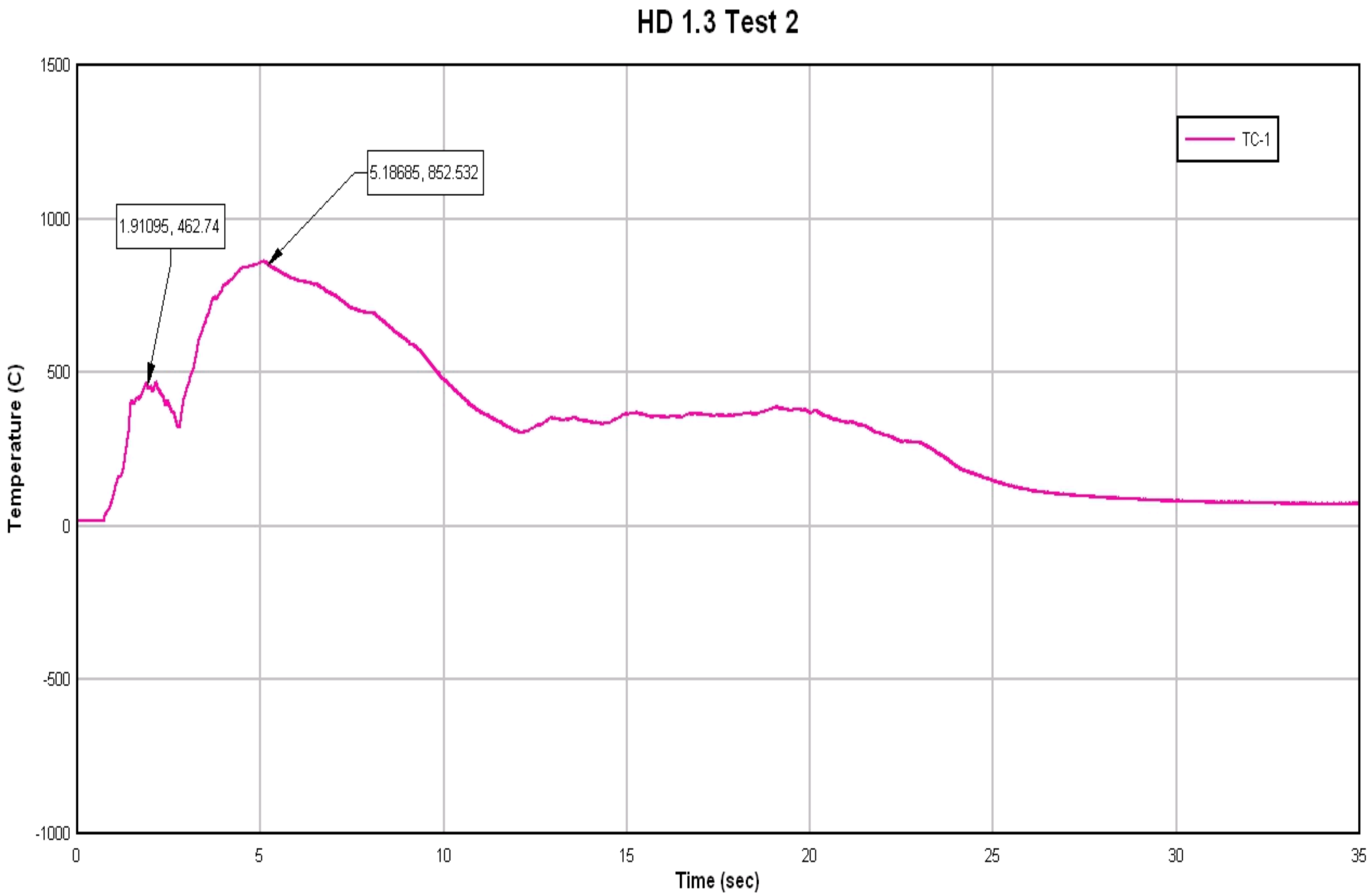

FIGURE III-C-1. Thermocouple #1.

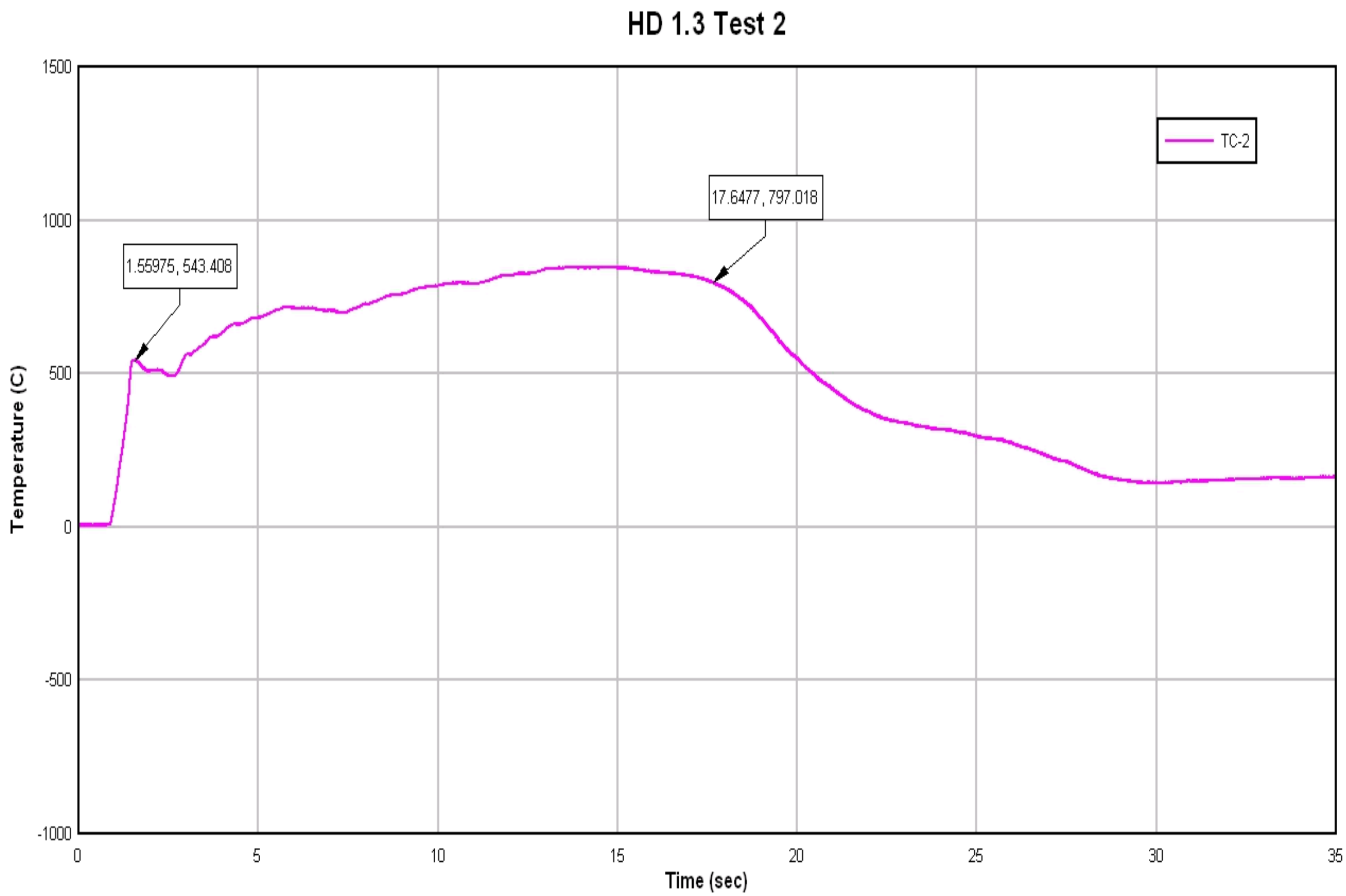

FIGURE III-C-2. Thermocouple #2.

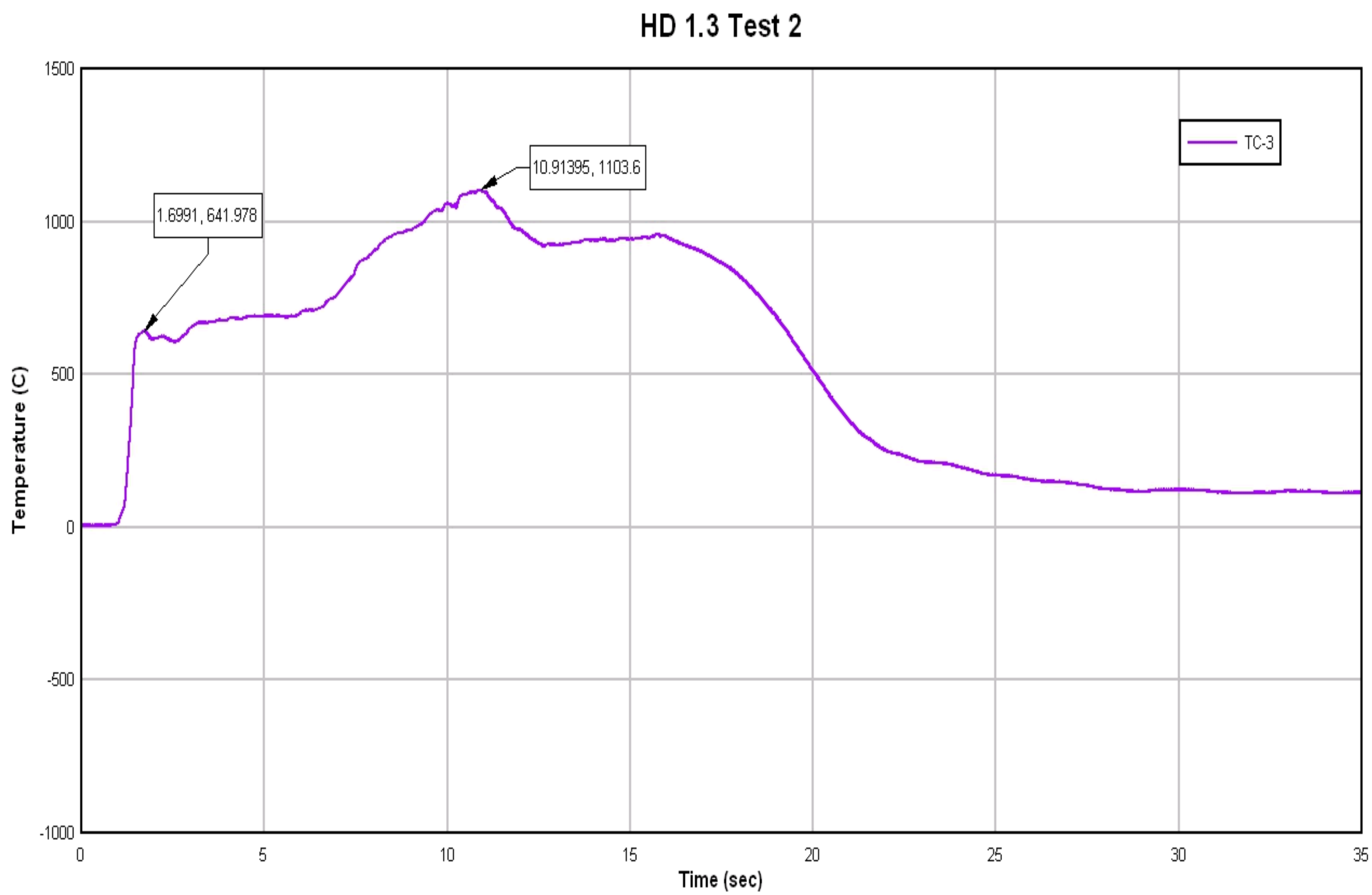

FIGURE III-C-3. Thermocouple #3.

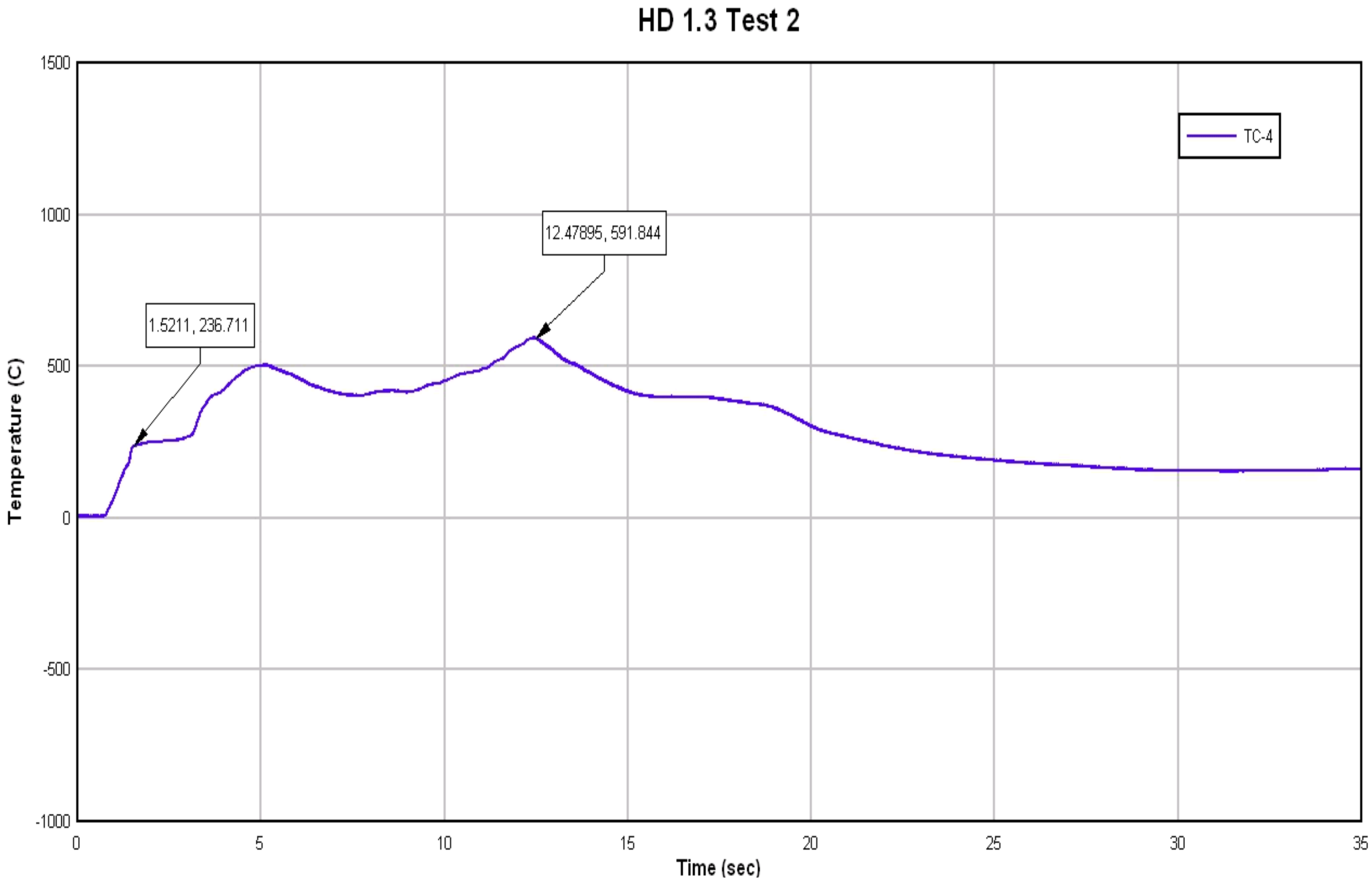

FIGURE III-C-4. Thermocouple #4.

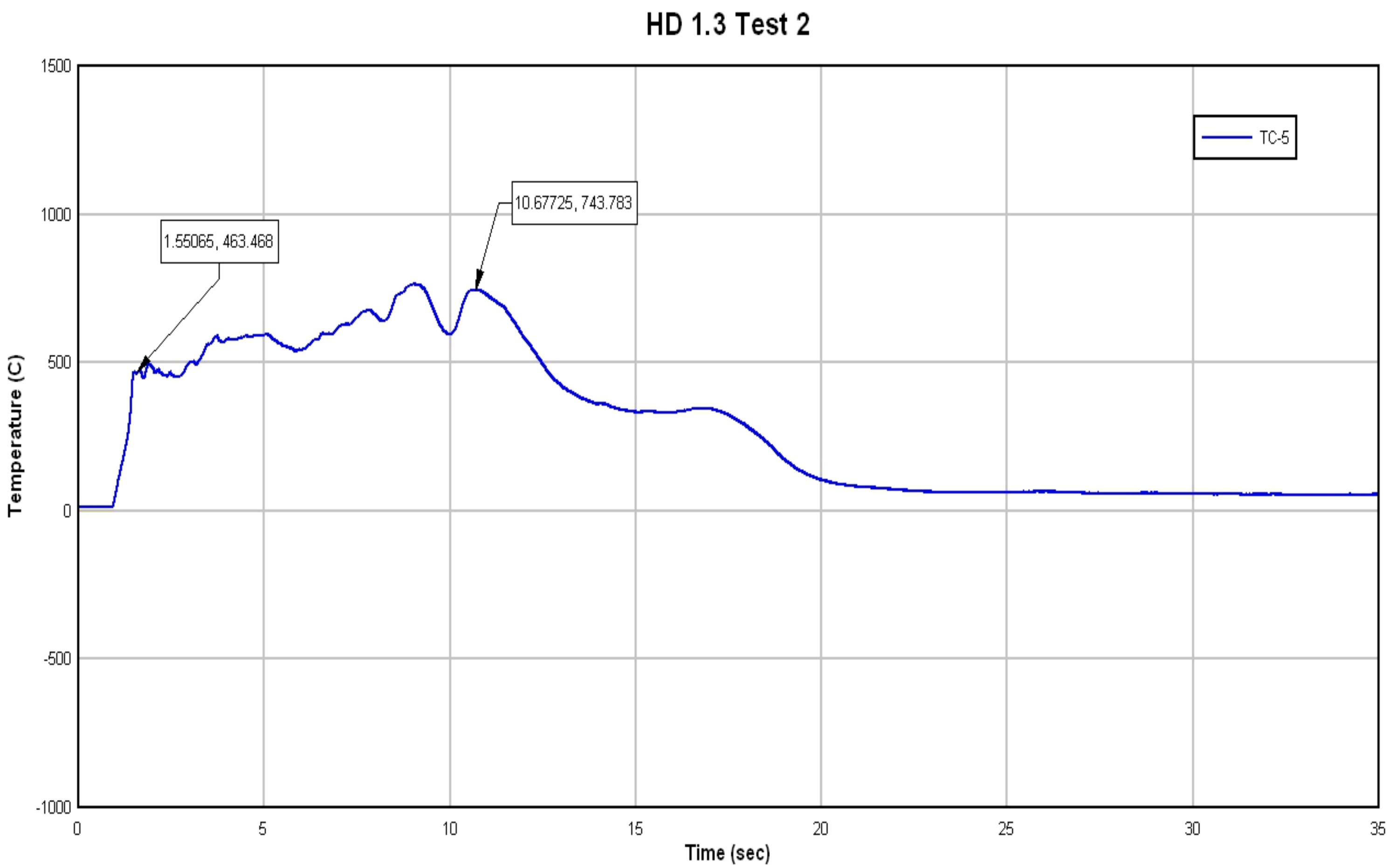

FIGURE III-C-5. Thermocouple #5.

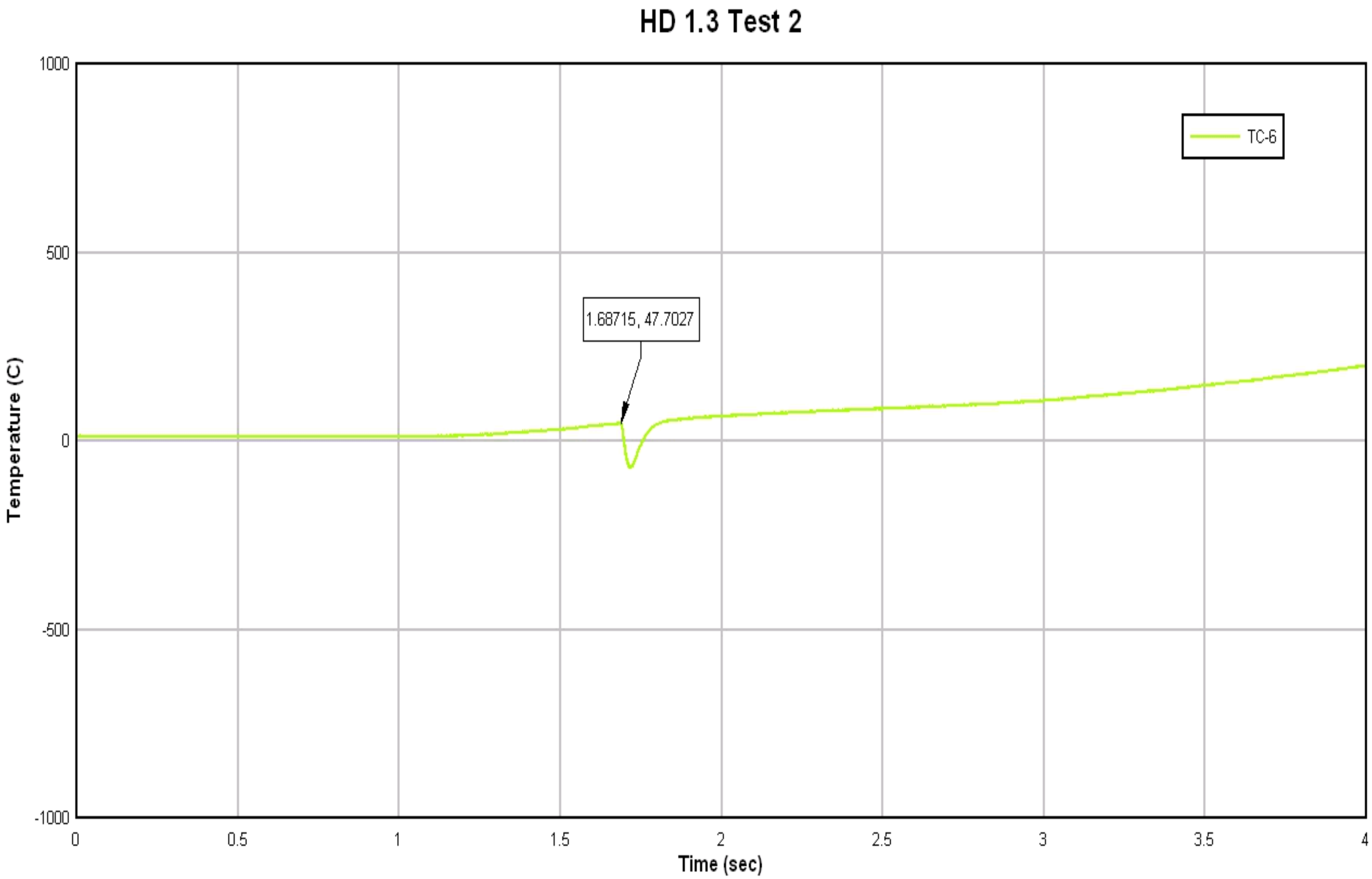

FIGURE III-C-6. Thermocouple #6.

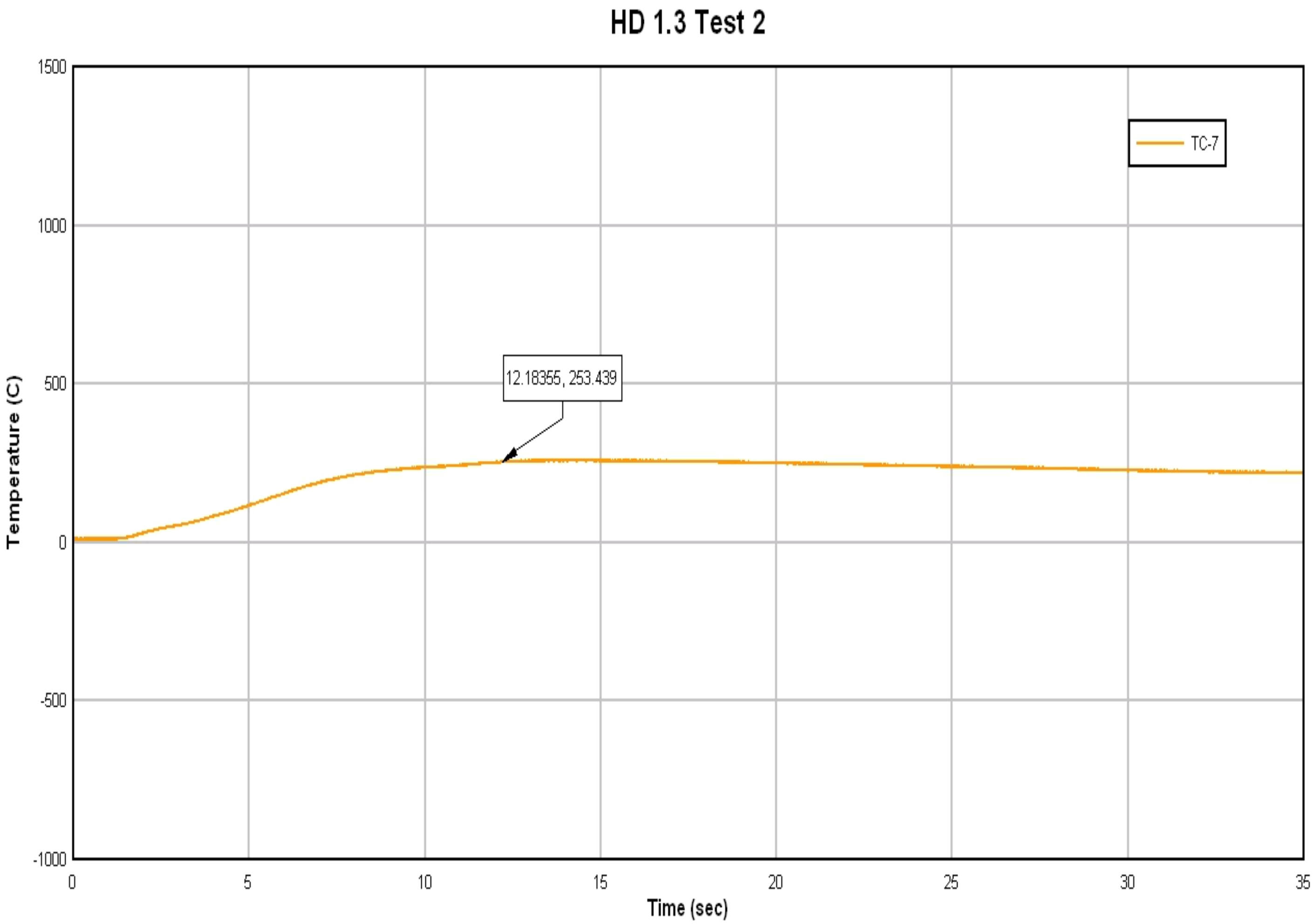

FIGURE III-C-7. Thermocouple #7.

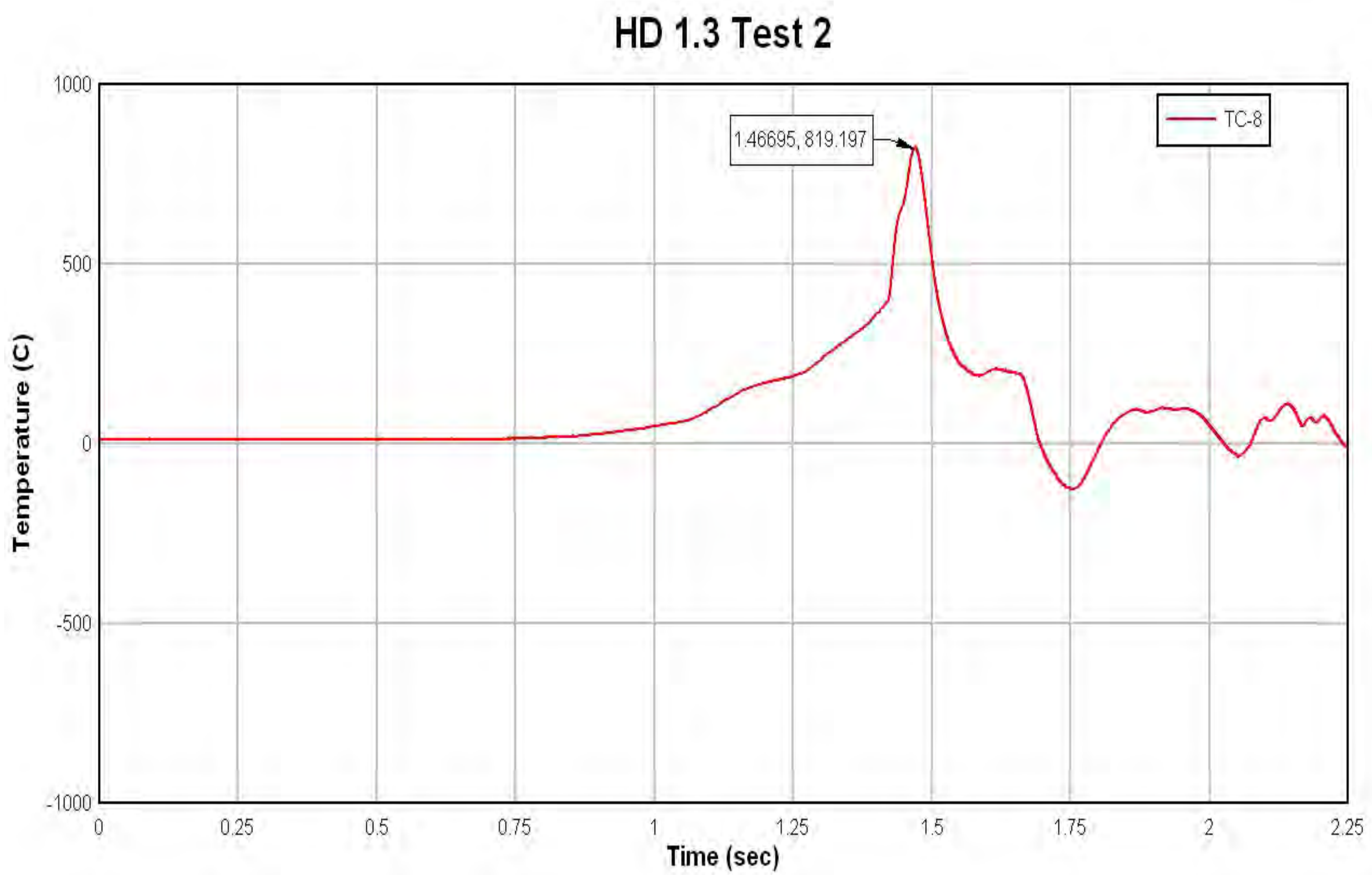

FIGURE III-C-8. Thermocouple #8.

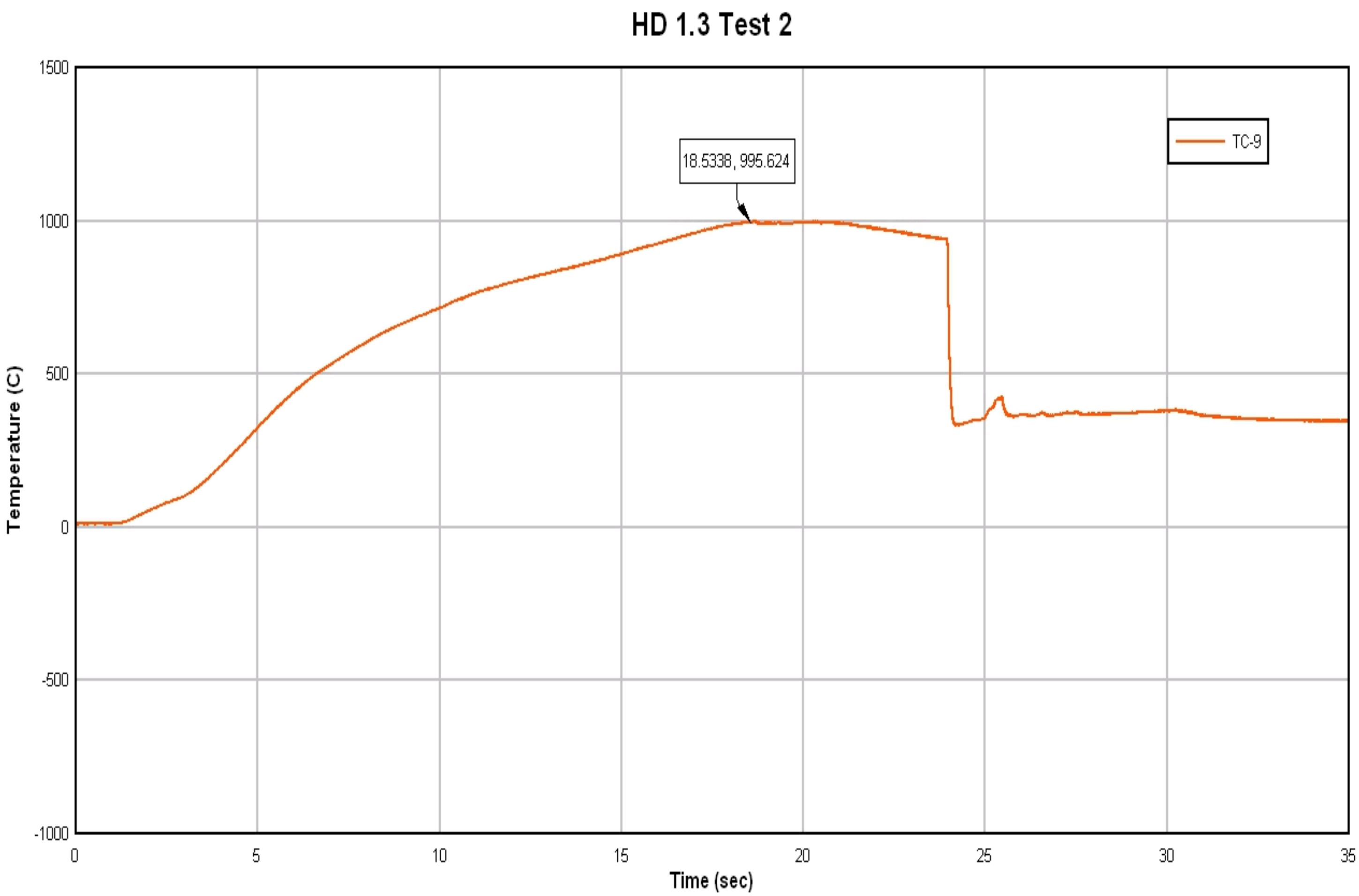

FIGURE III-C-9. Thermocouple #9.

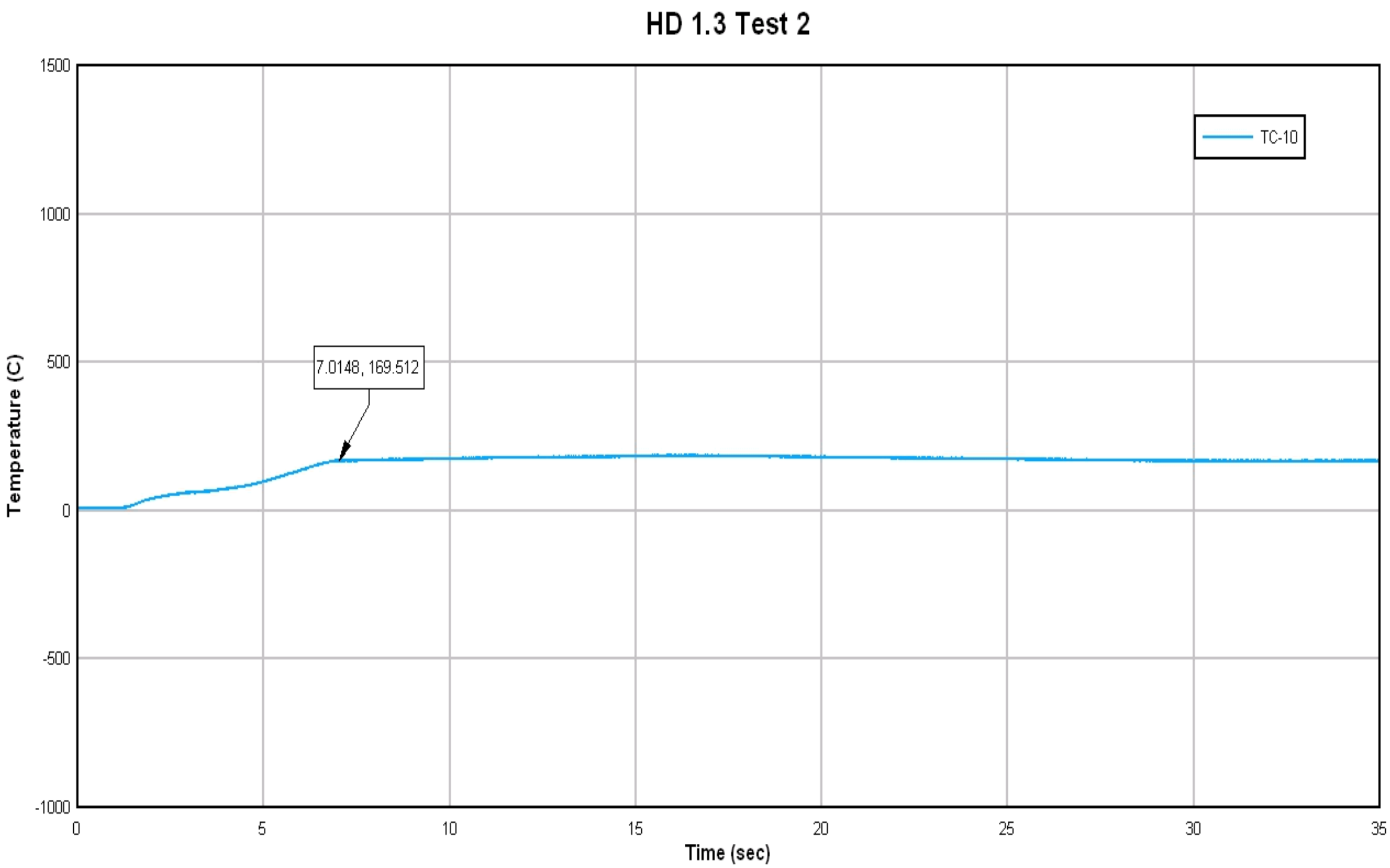

FIGURE III-C-10. Thermocouple #10.

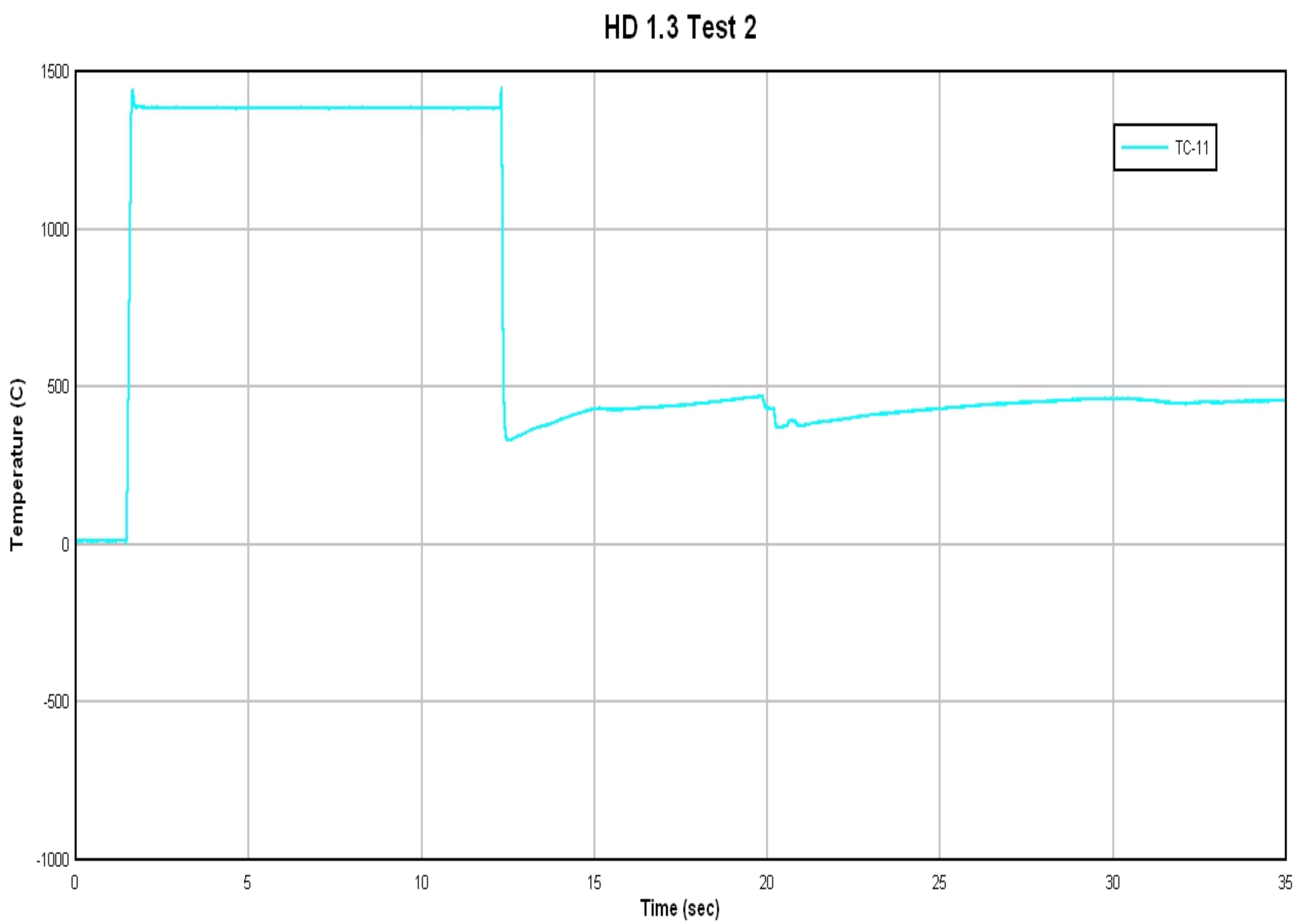

FIGURE III-C-11. Thermocouple #11.

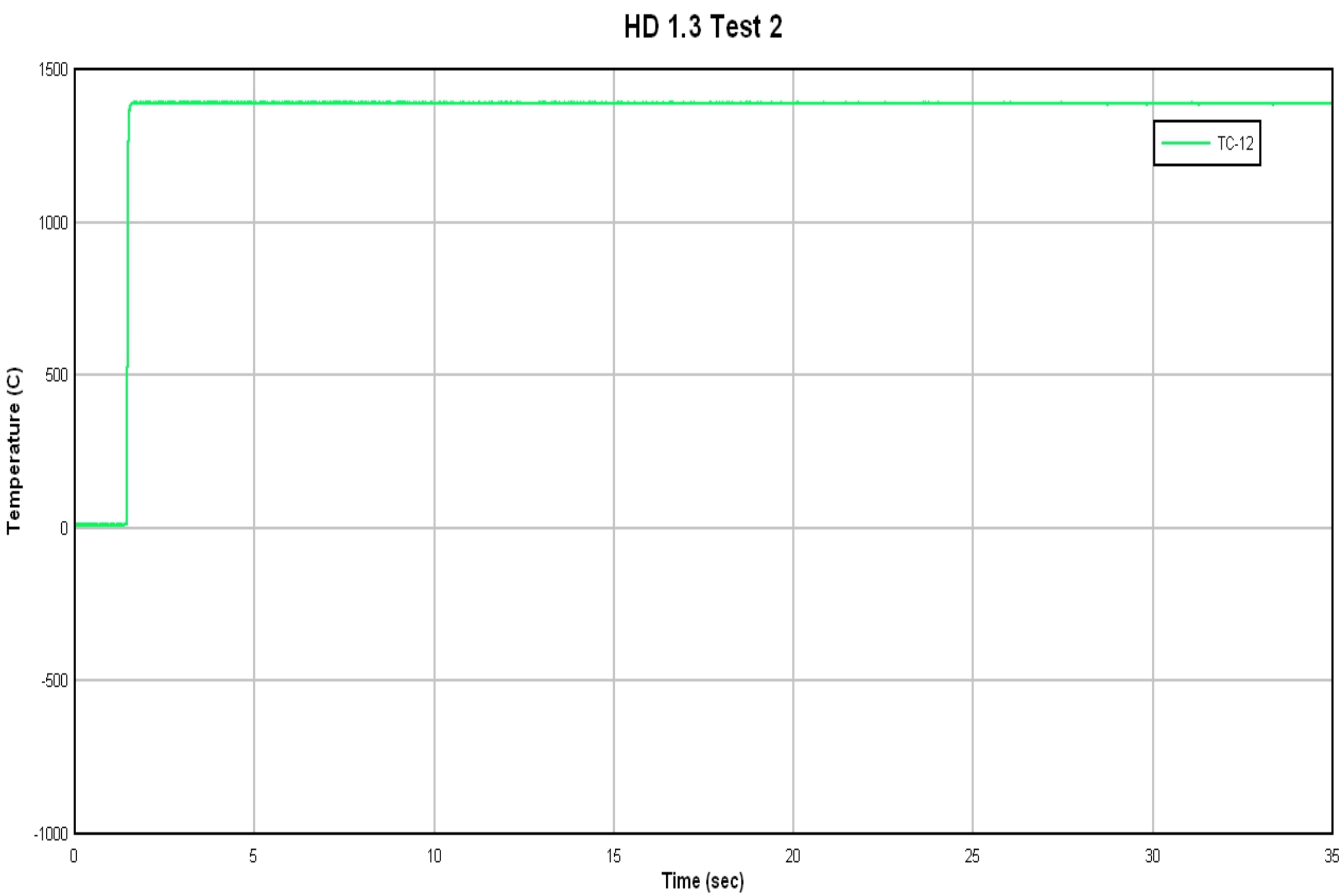

FIGURE III-C-12. Thermocouple #12.

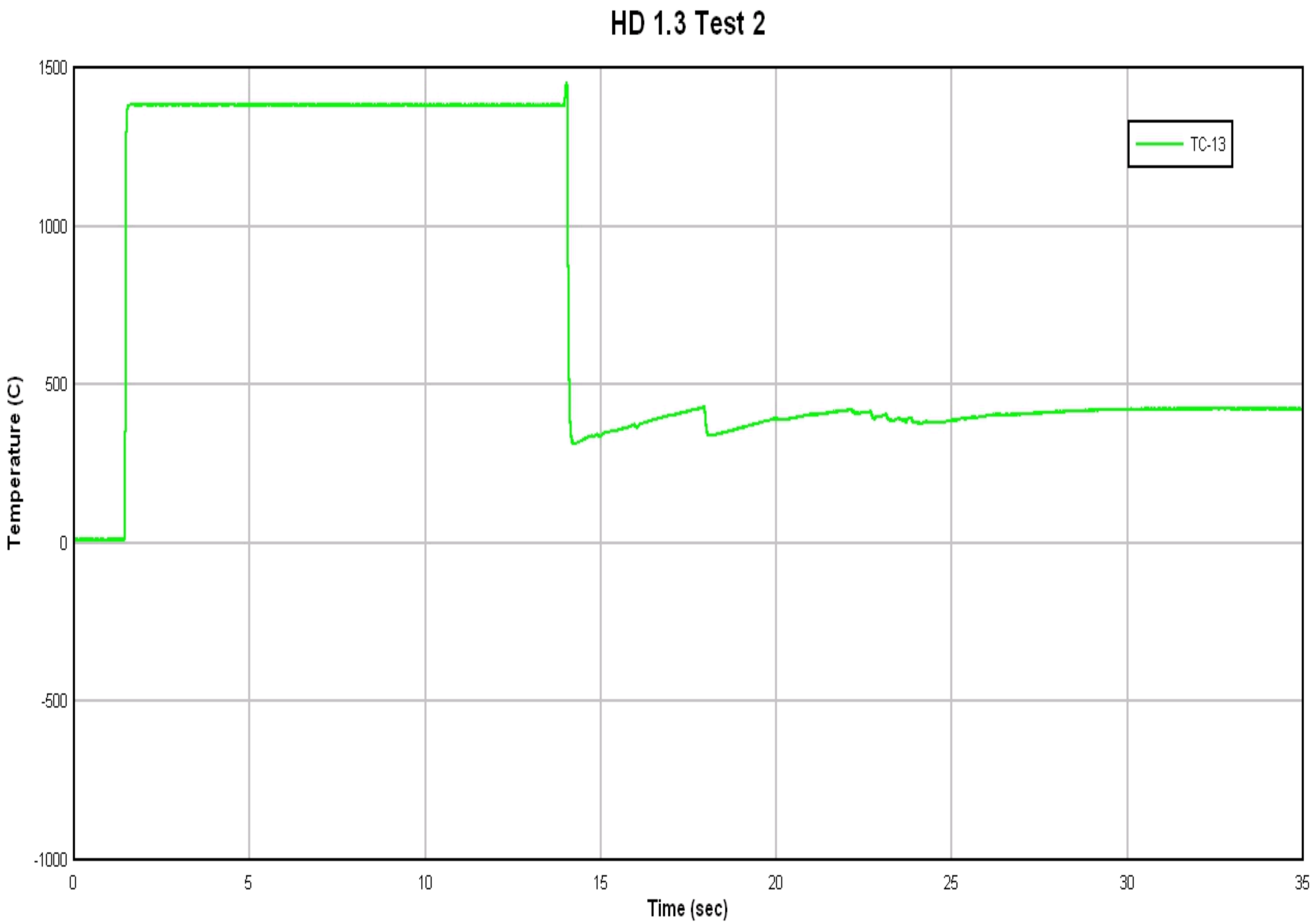

FIGURE III-C-13. Thermocouple #13.

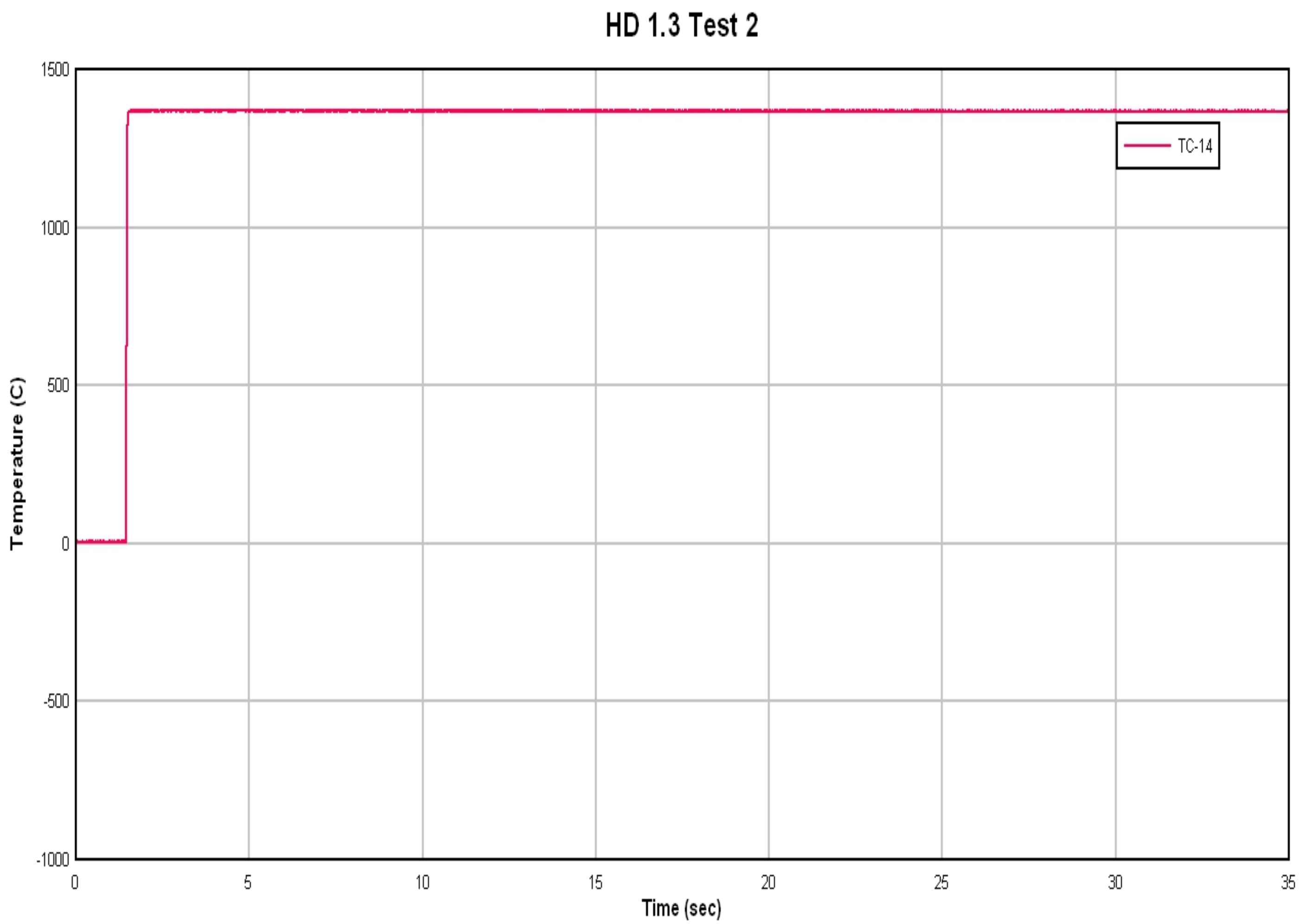

FIGURE III-C-14. Thermocouple #14.

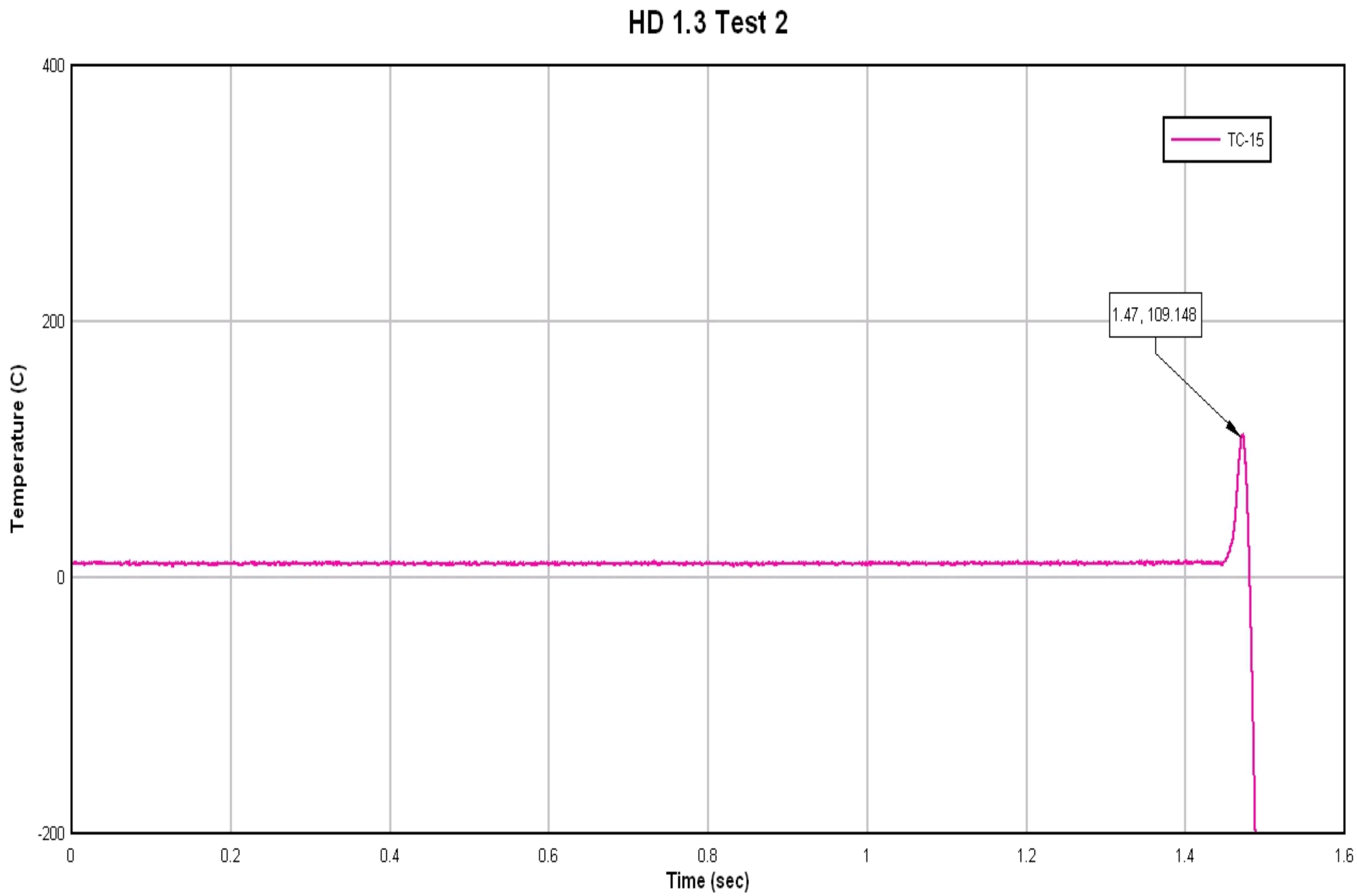

FIGURE III-C-15. Thermocouple #15.

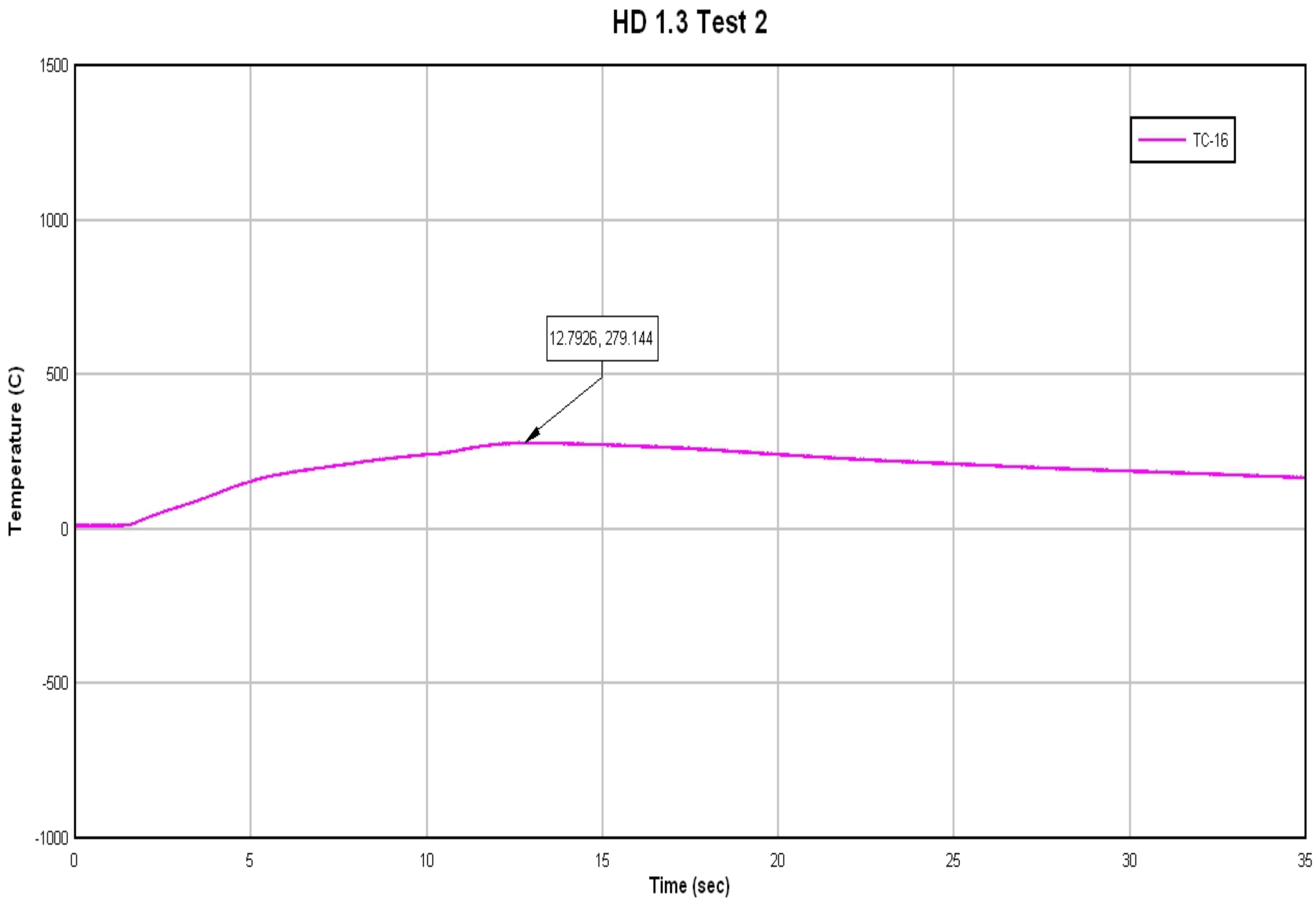

FIGURE III-C-16. Thermocouple #16.

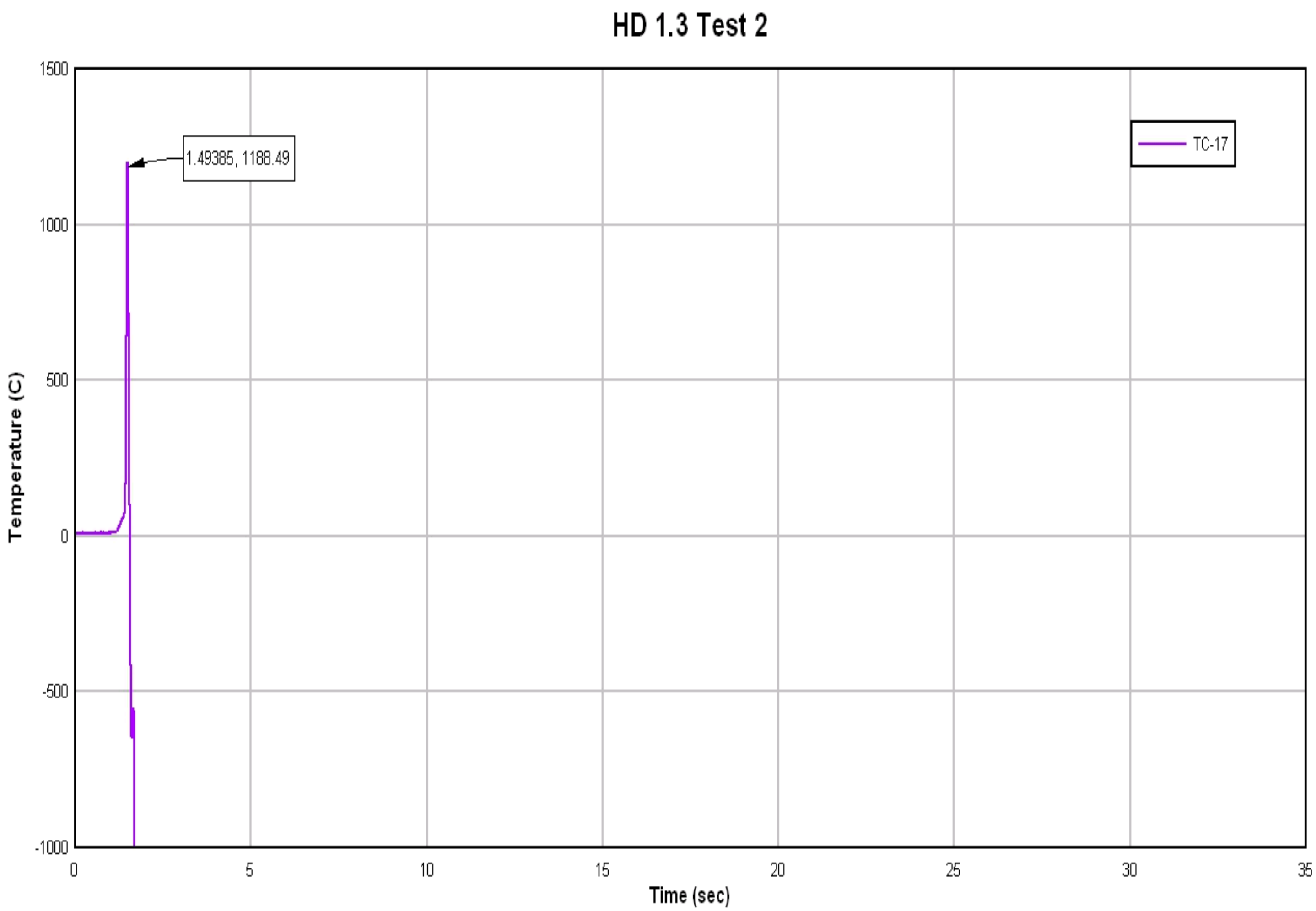

FIGURE III-C-17. Thermocouple #17.

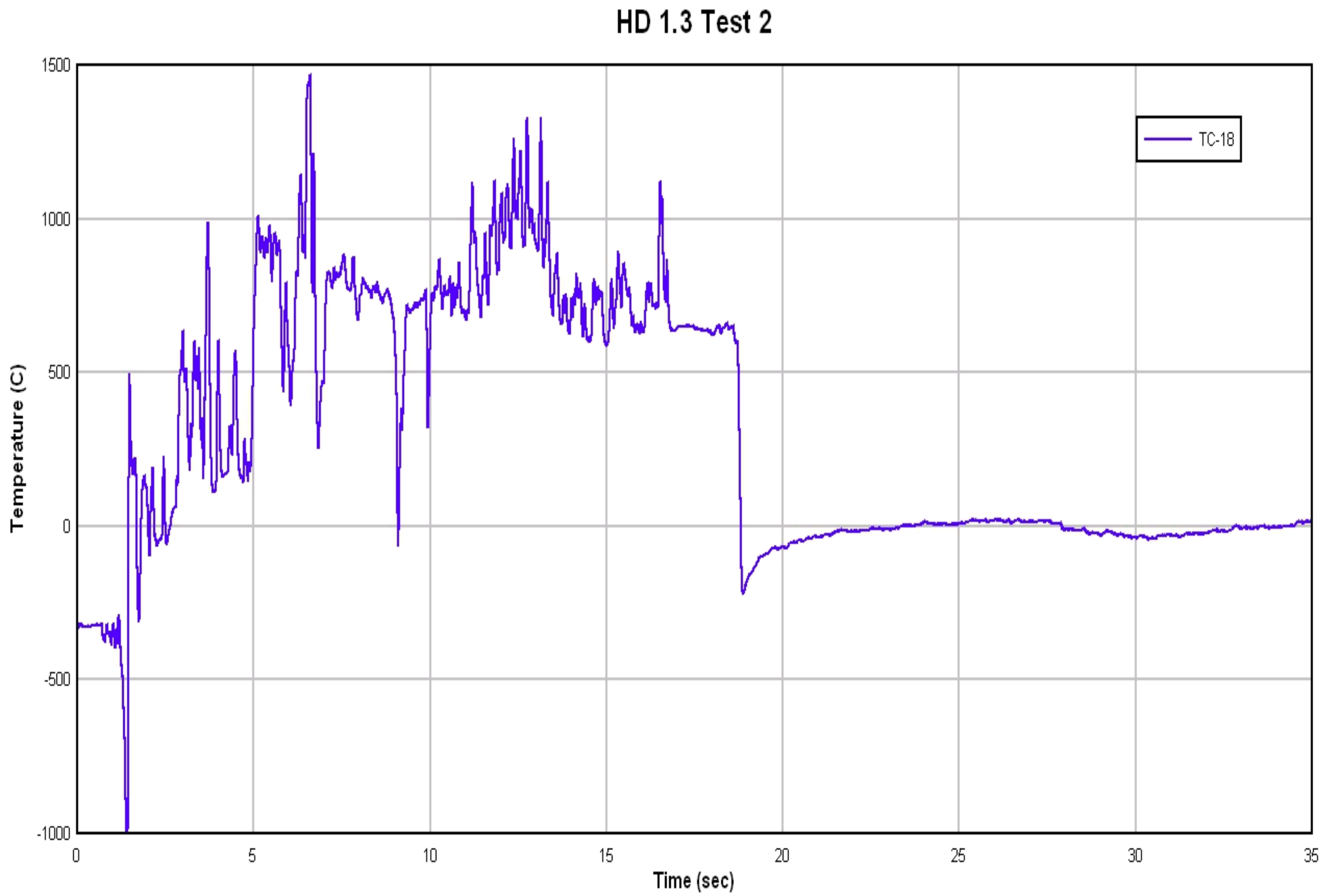

FIGURE III-C-18. Thermocouple #18.

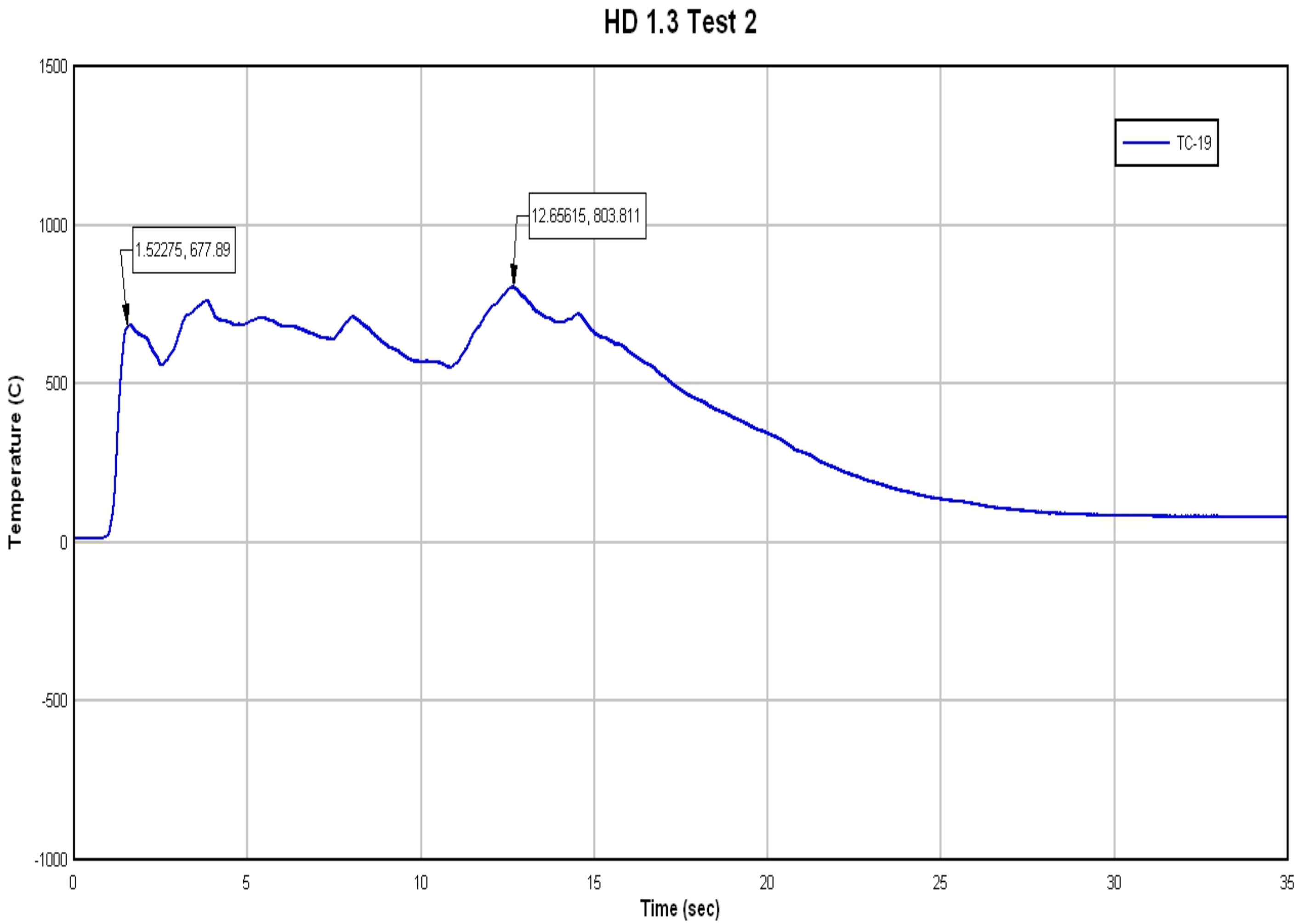

FIGURE III-C-19. Thermocouple #19.

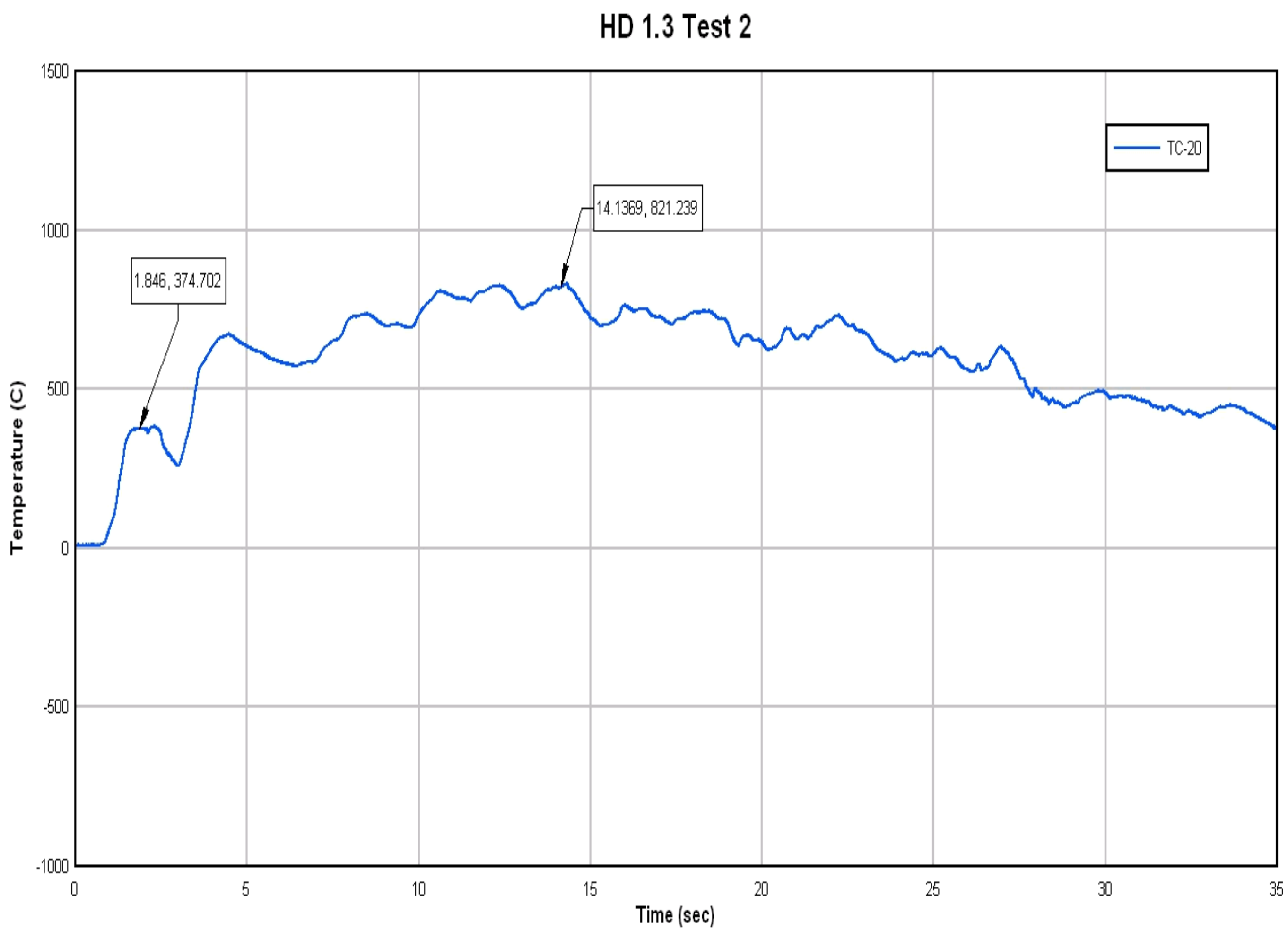

FIGURE III-C-20. Thermocouple #20.

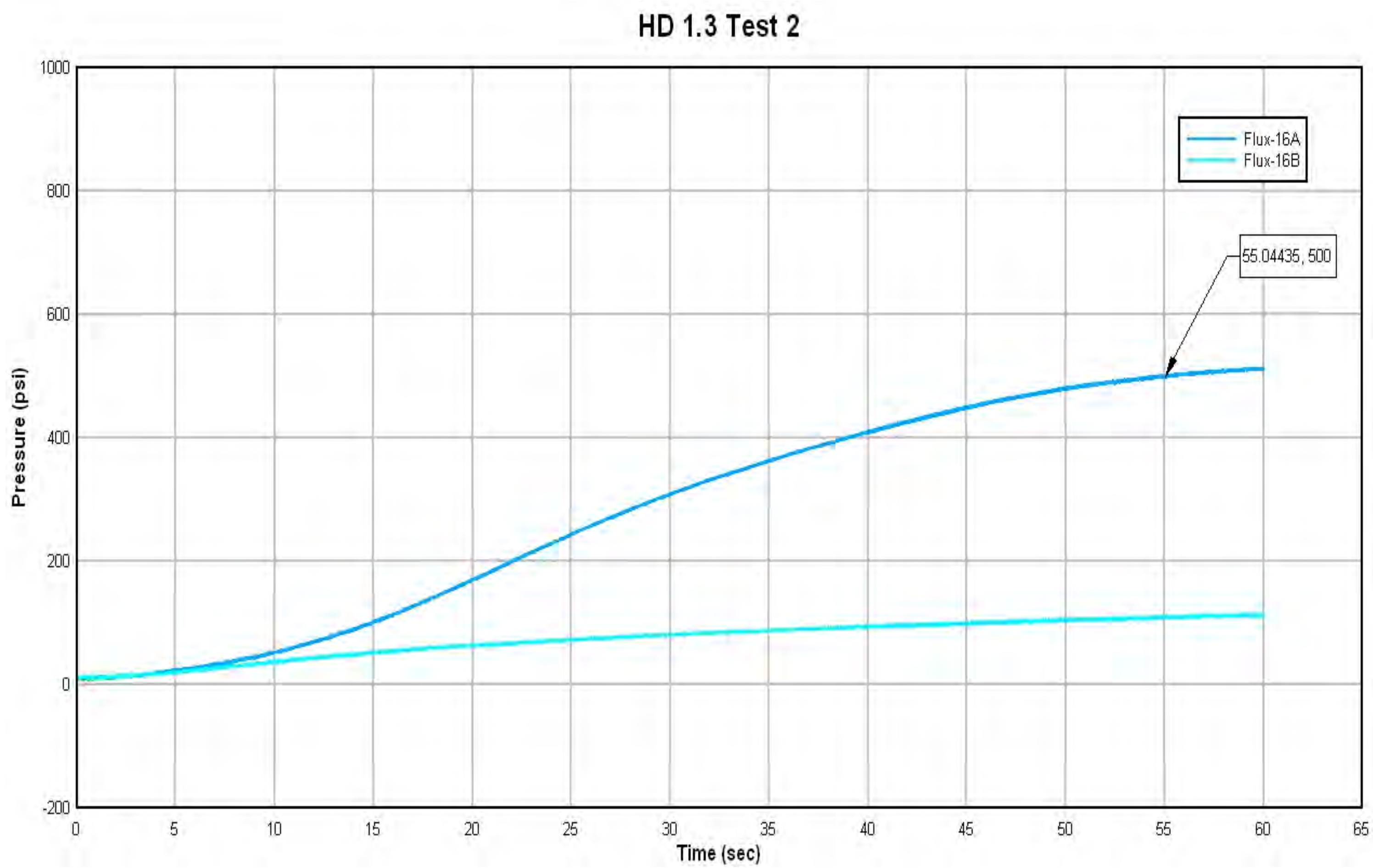

FIGURE III-C-21. Flux Gage #16A and 16B (Inside).

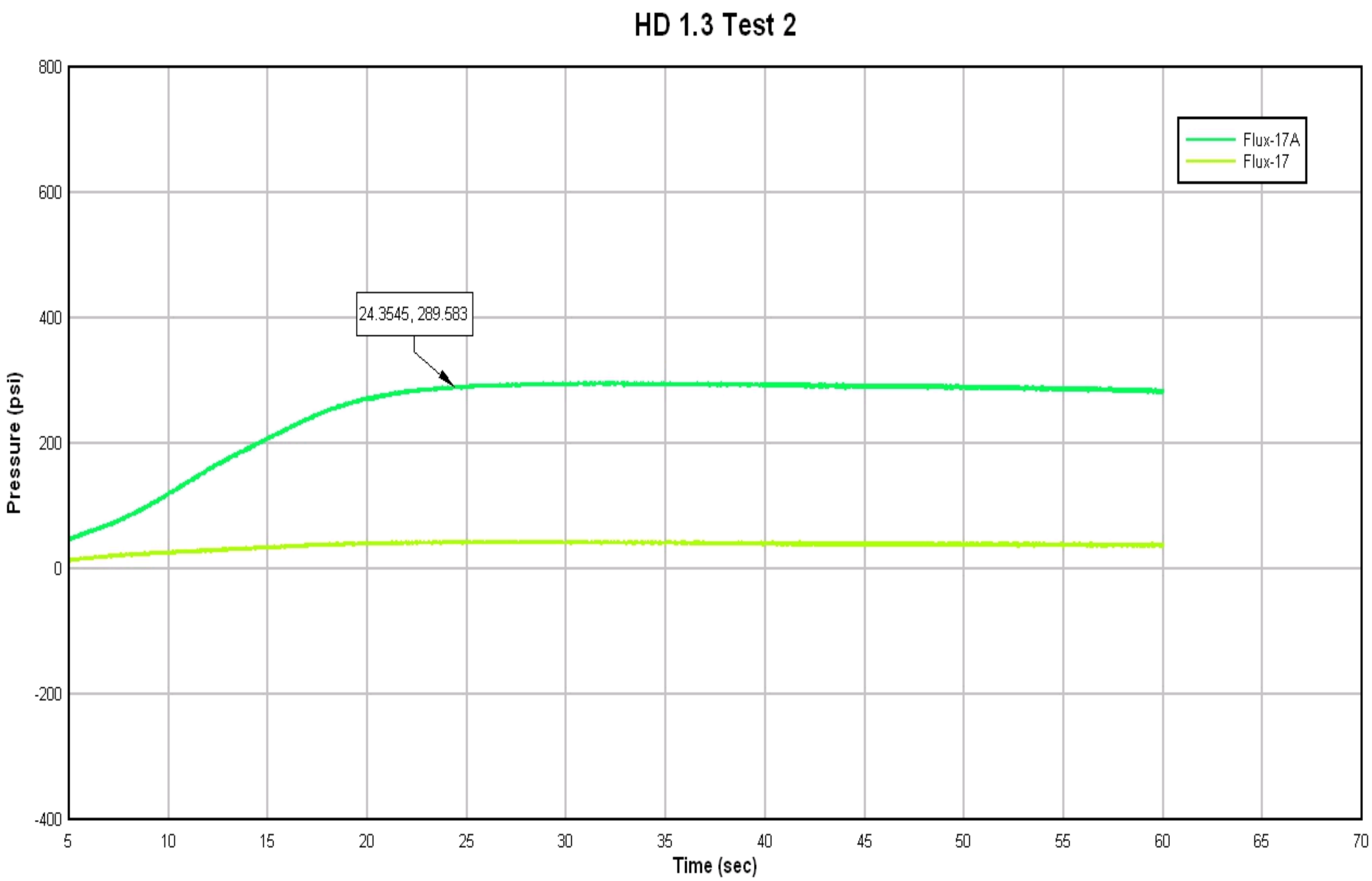

FIGURE III-C-22. Flux Gage #17A and 17B (Inside).

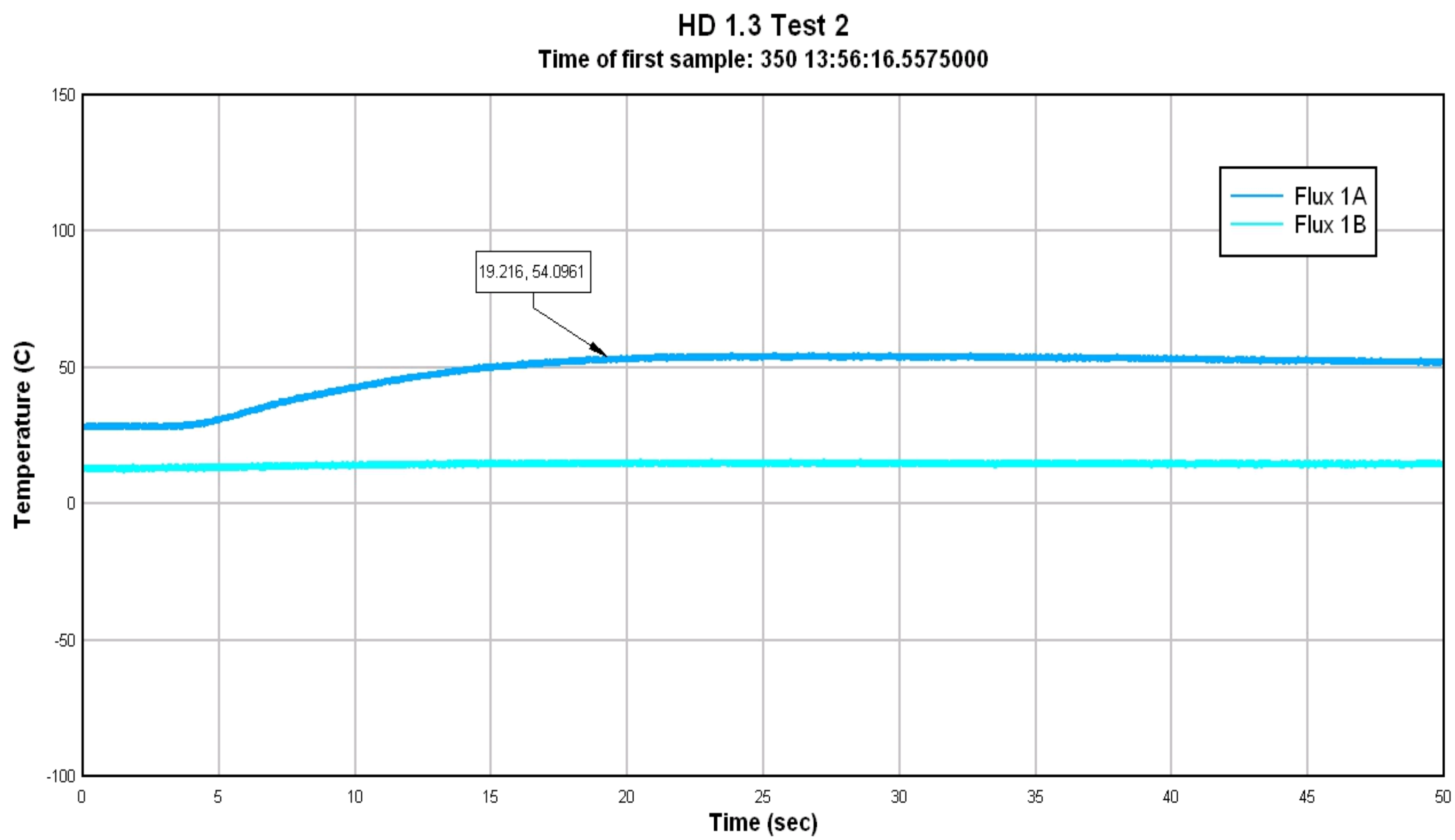

FIGURE III-C-23. Flux Gage #1A and 1B (Outside).

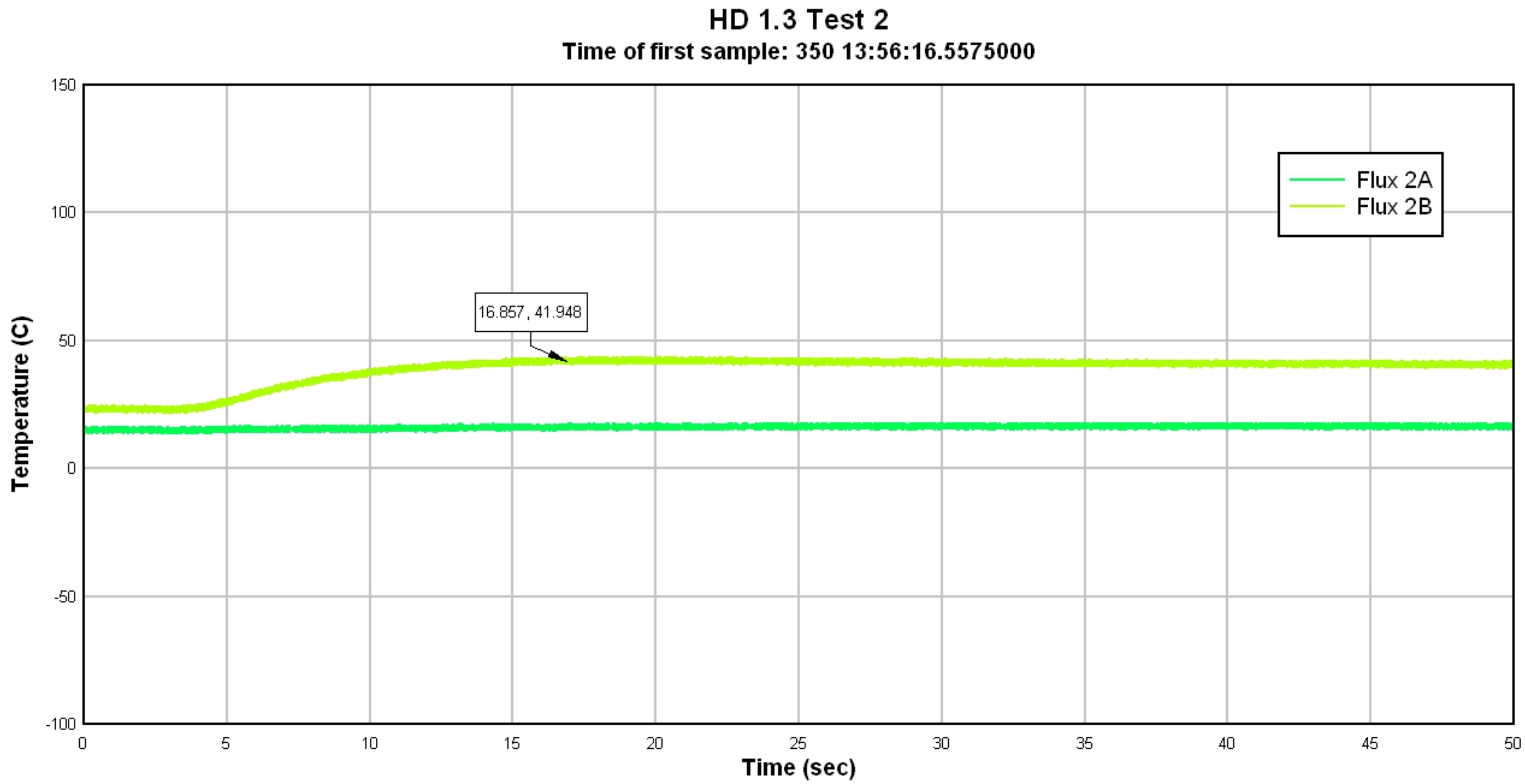

FIGURE III-C-24. Flux Gage #2A and 2B (Outside).

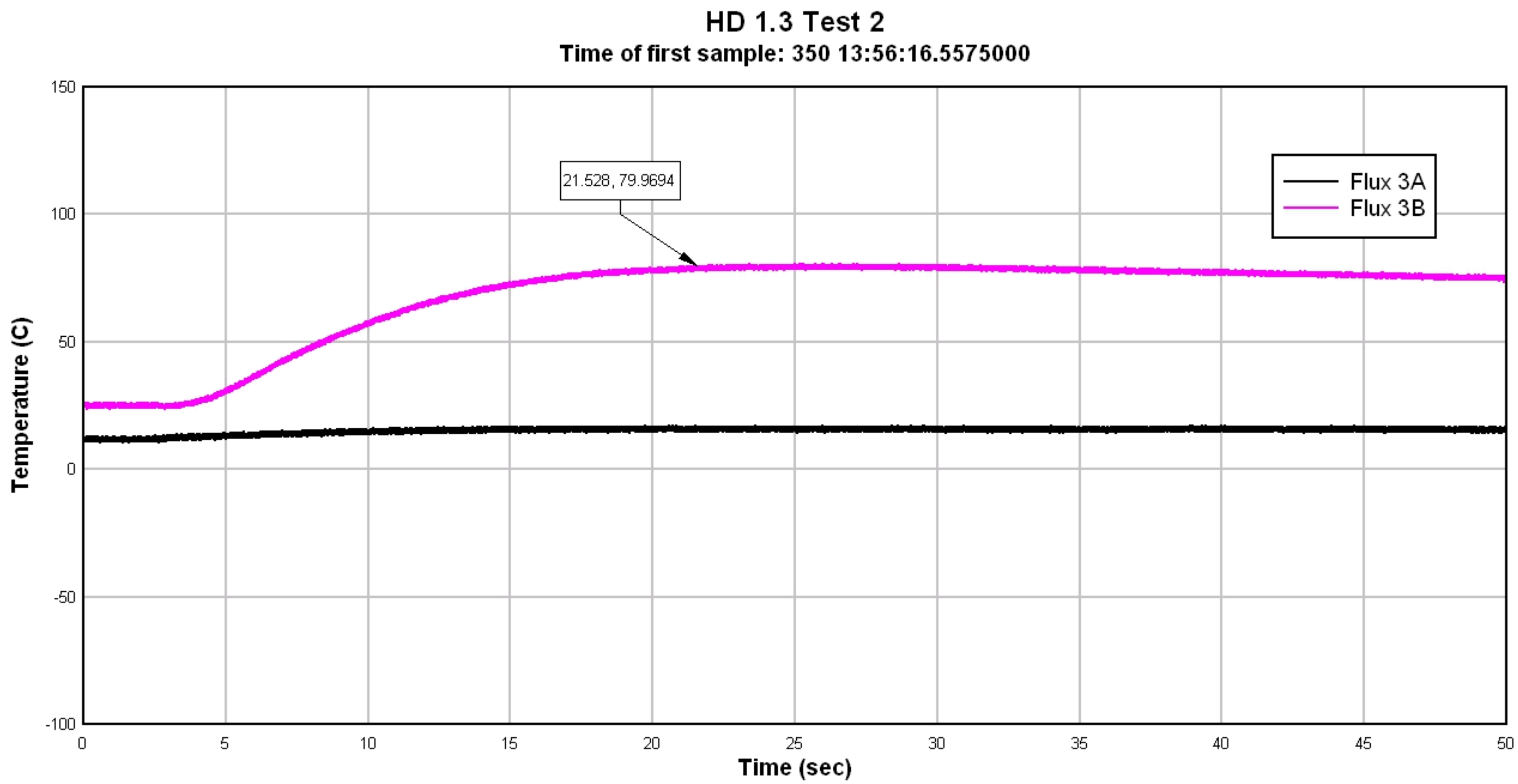

FIGURE III-C-25. Flux Gage #3A and 3B (Outside).

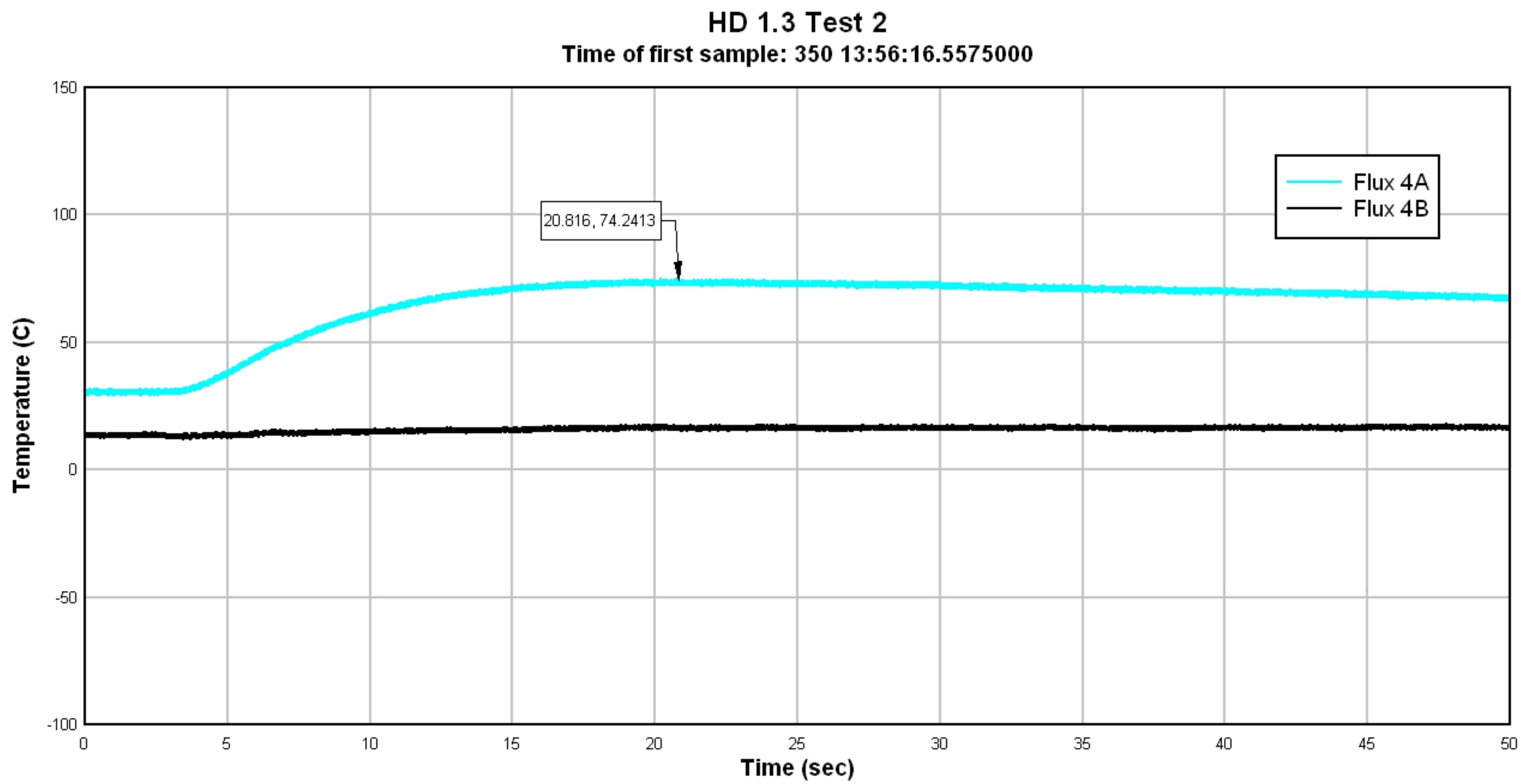

FIGURE III-C-26. Flux Gage #4A and 4B (Outside).

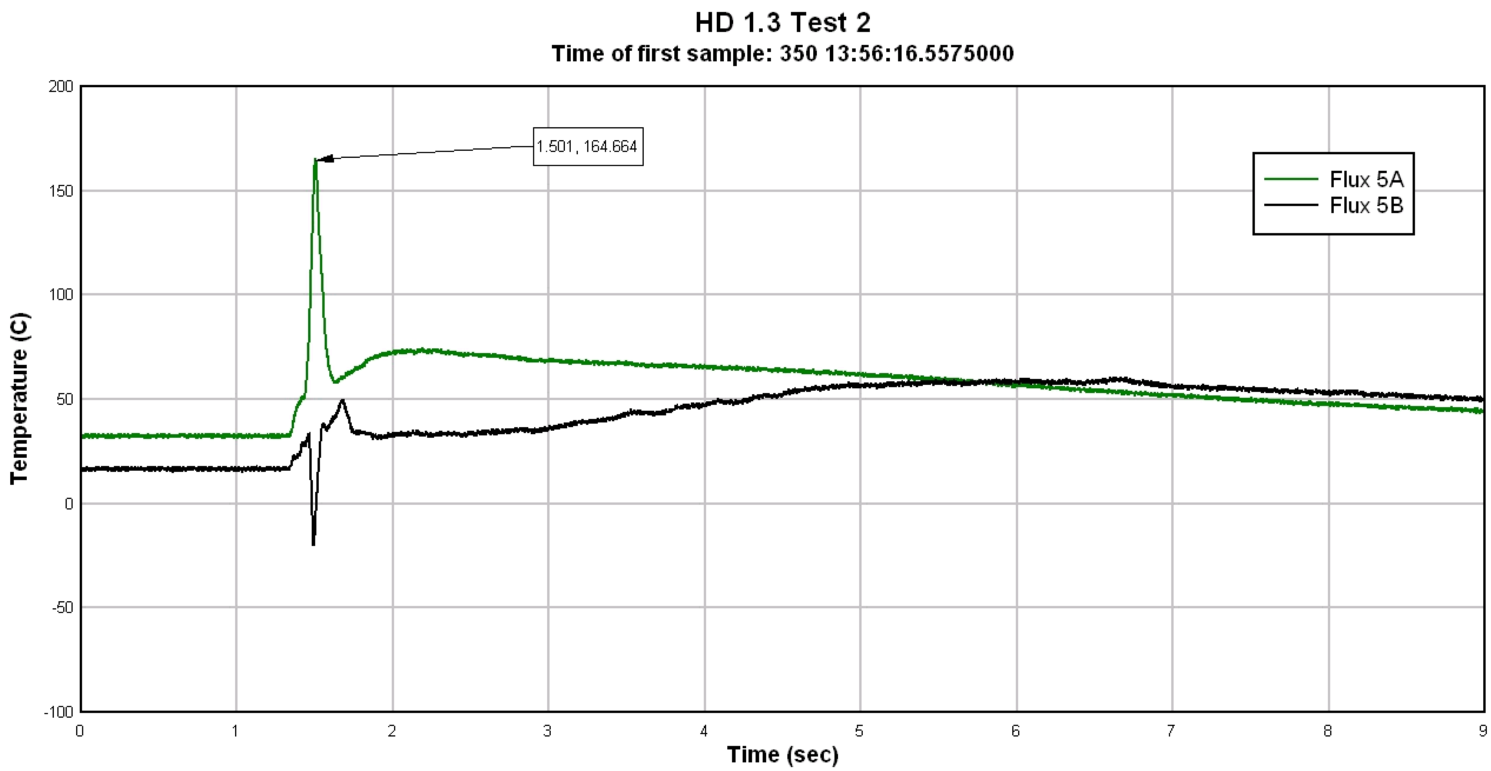

FIGURE III-C-27. Flux Gage #5A and 5B (Outside).

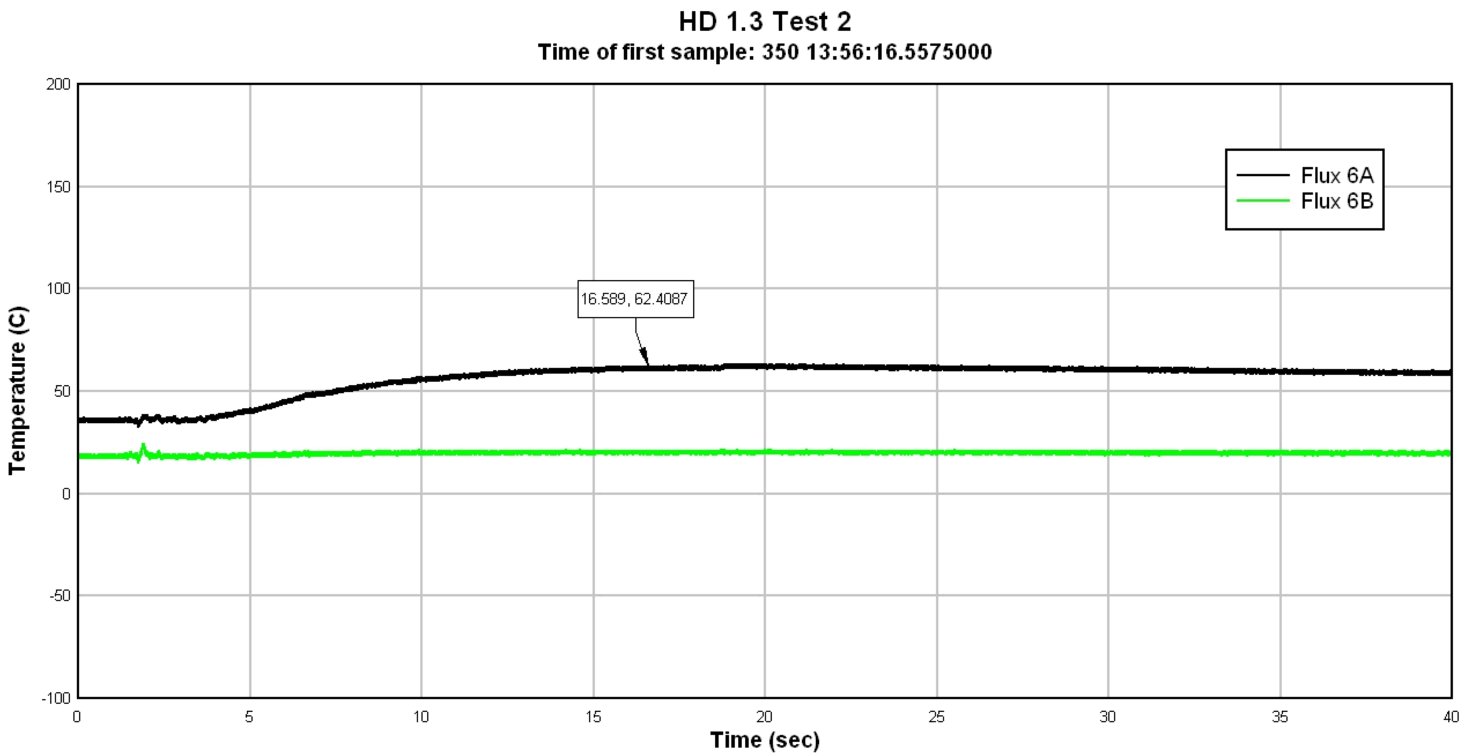

FIGURE III-C-28. Flux Gage #6A and 6B (Outside).

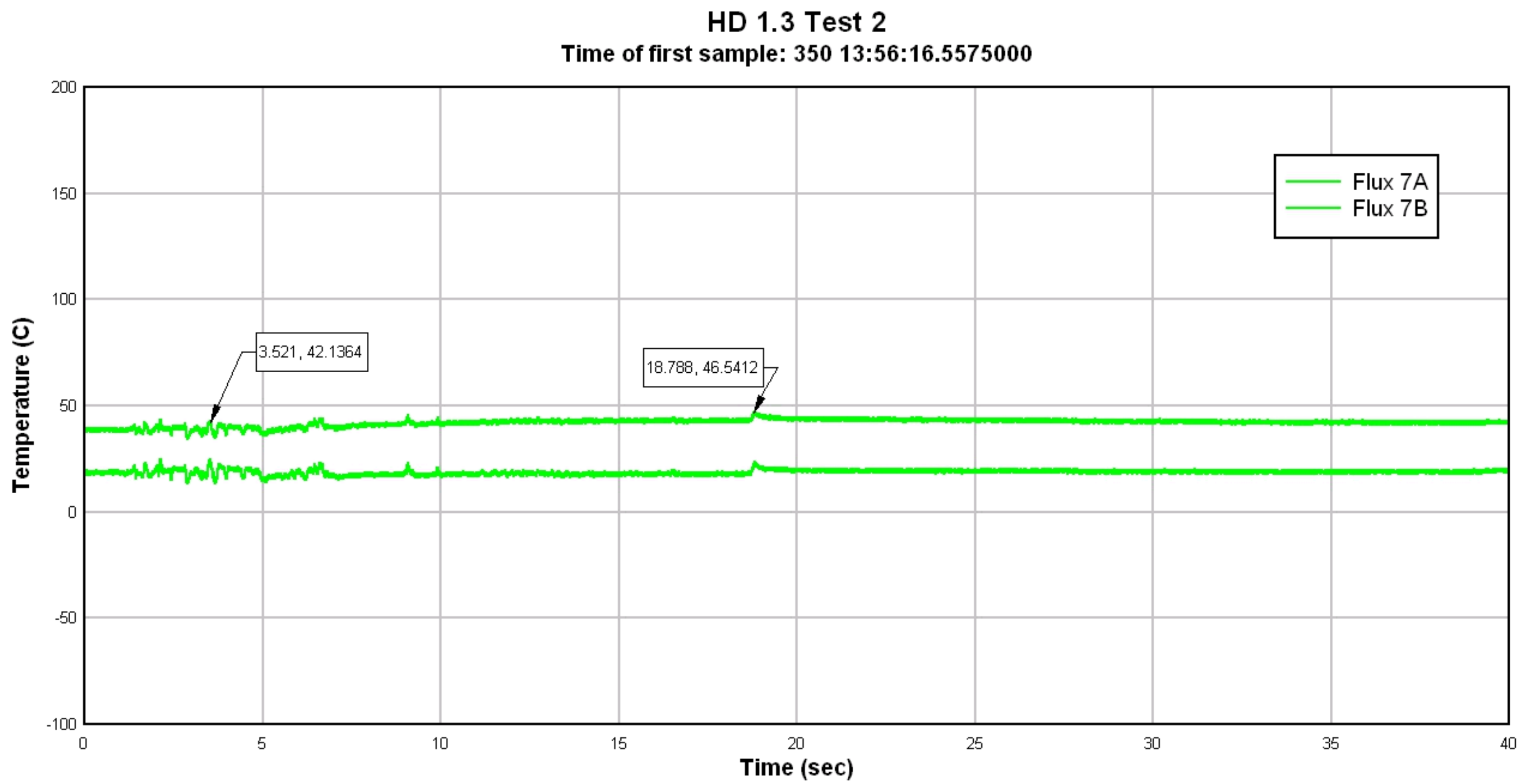

FIGURE III-C-29. Flux Gage #7A and 7B (Outside).

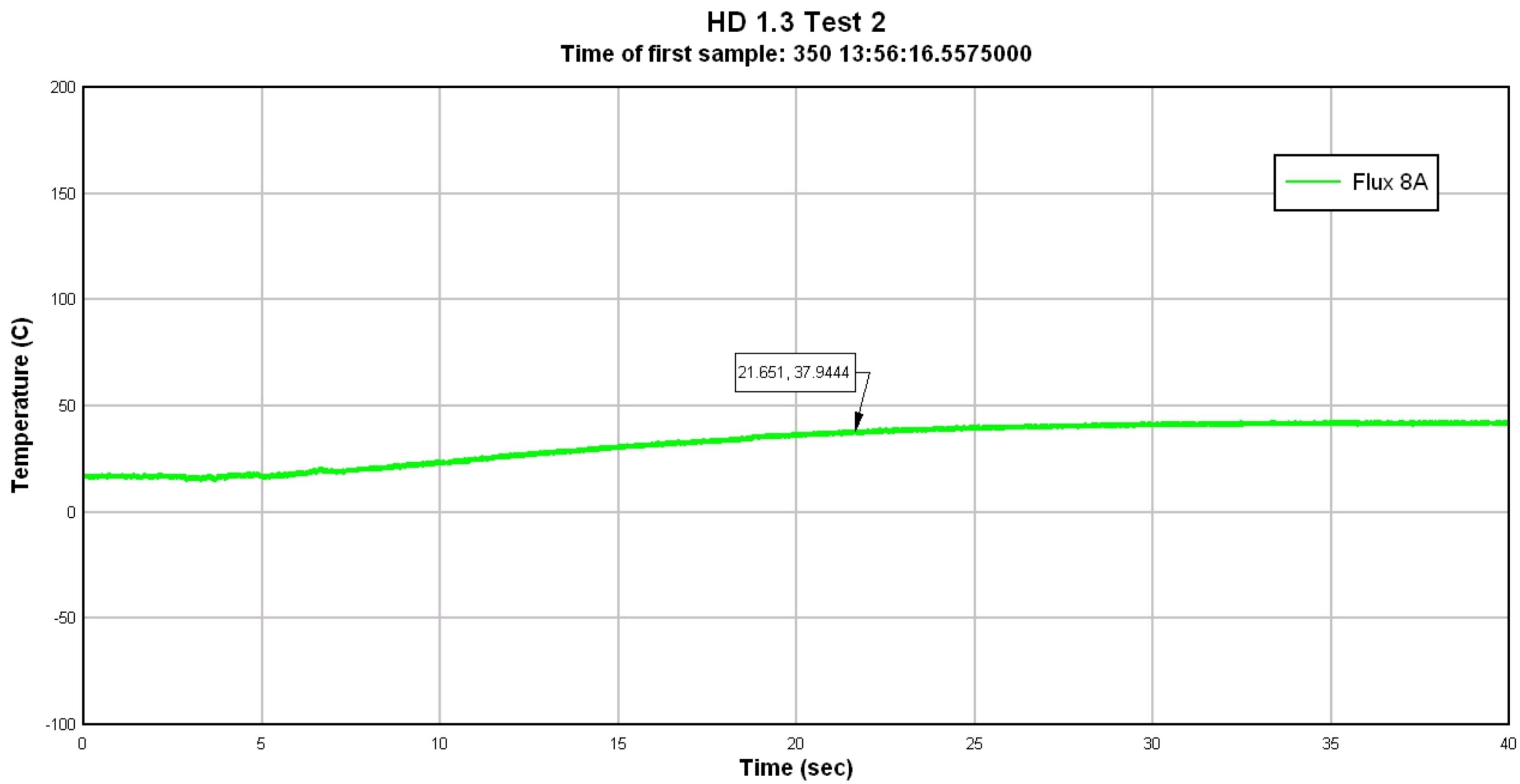

FIGURE III-C-30. Flux Gage #9A (Outside).

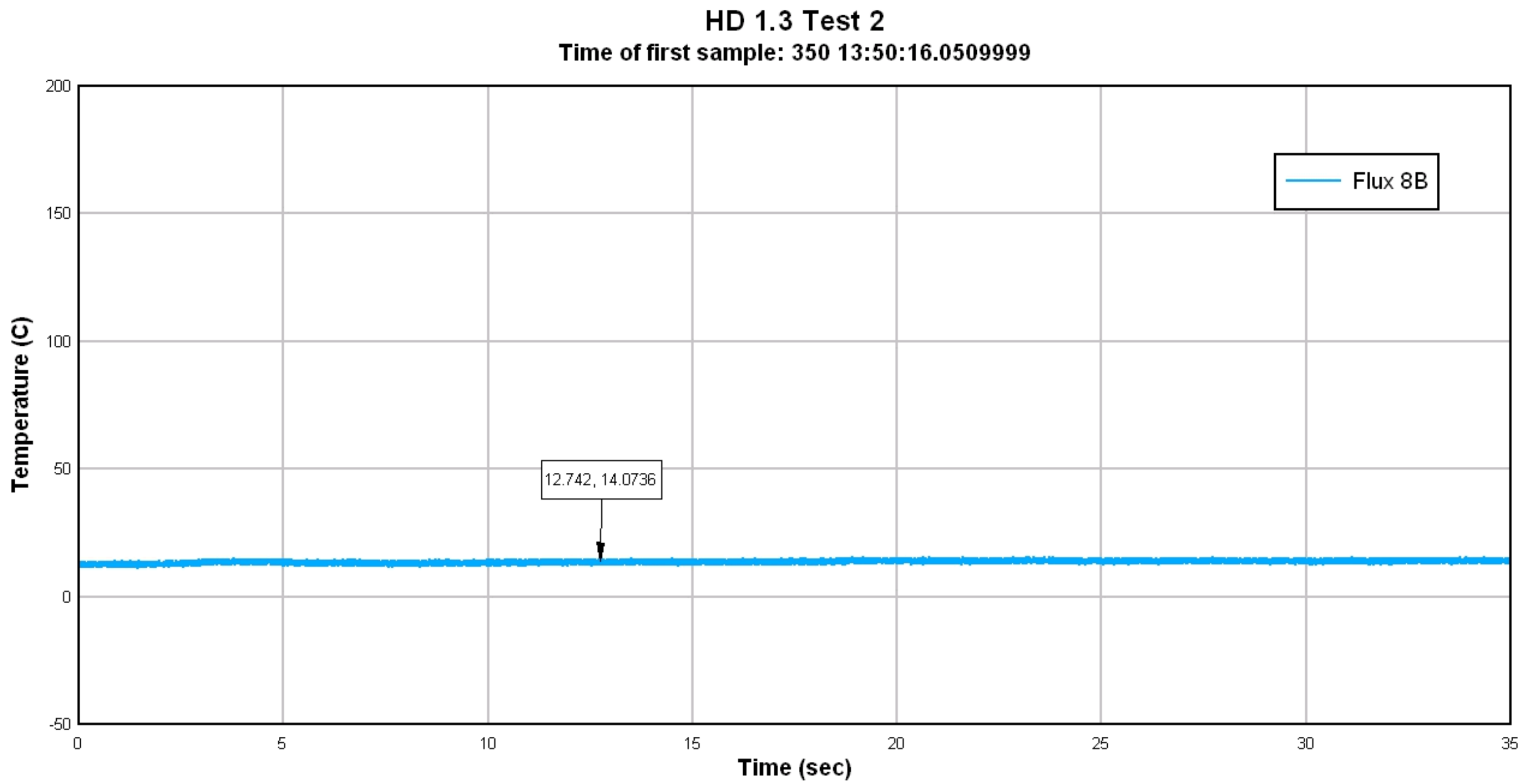

FIGURE III-C-31. Flux Gage #8B (Outside).

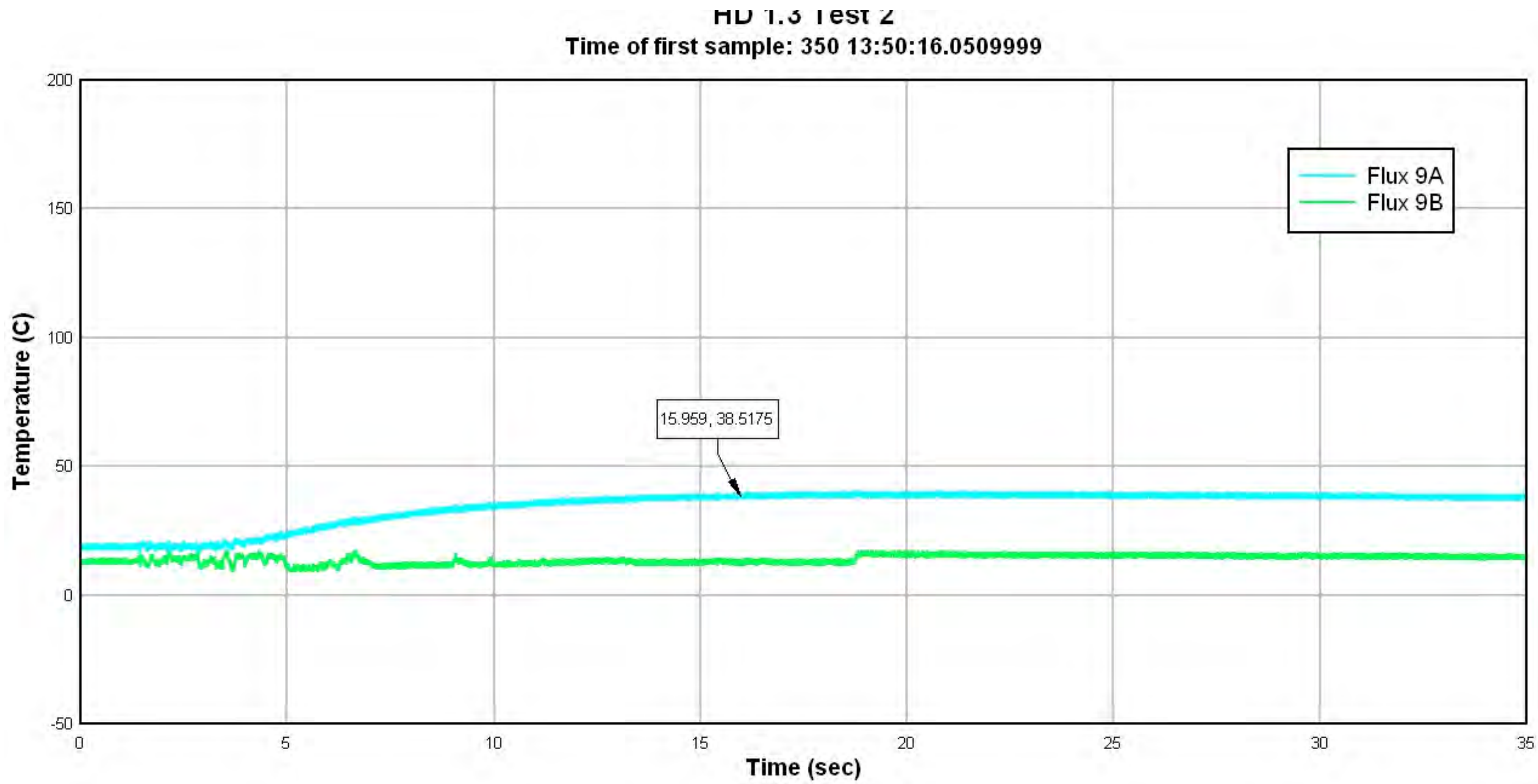

FIGURE III-C-32. Flux Gage #9A and 9B (Outside).

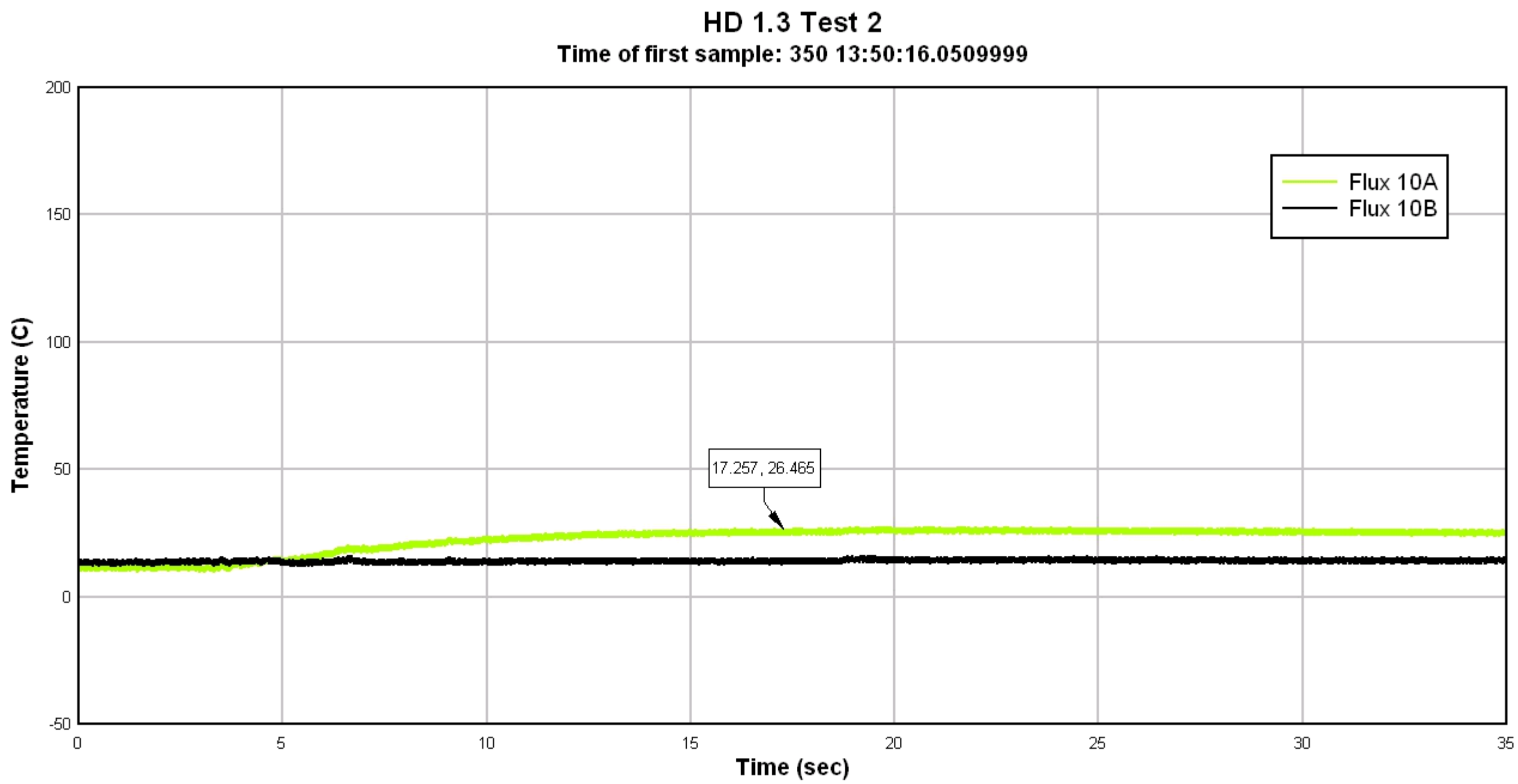

FIGURE III-C-33. Flux Gage #10A and 10B (Outside).

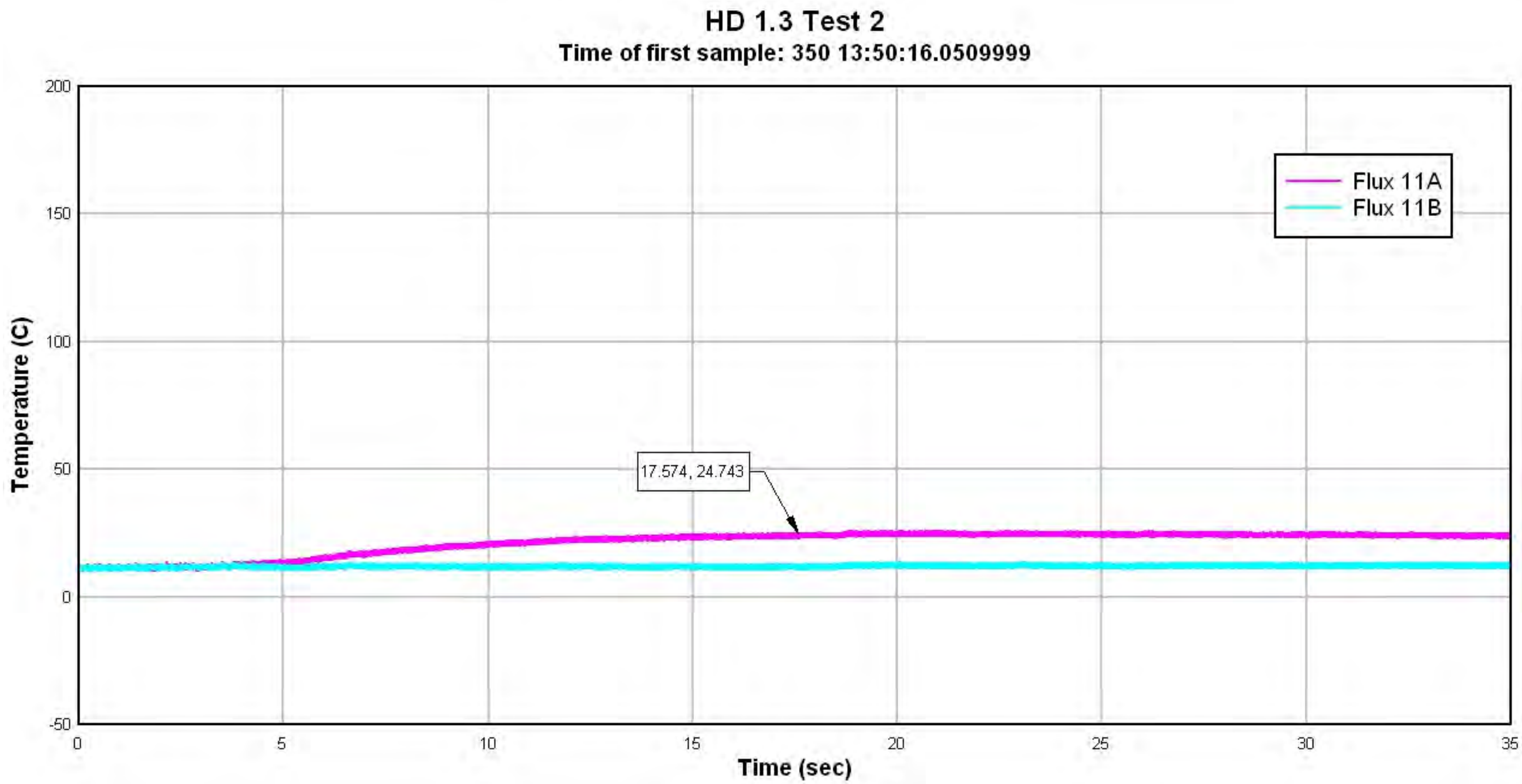

FIGURE III-C-34. Flux Gage #11A and 11B (Outside).

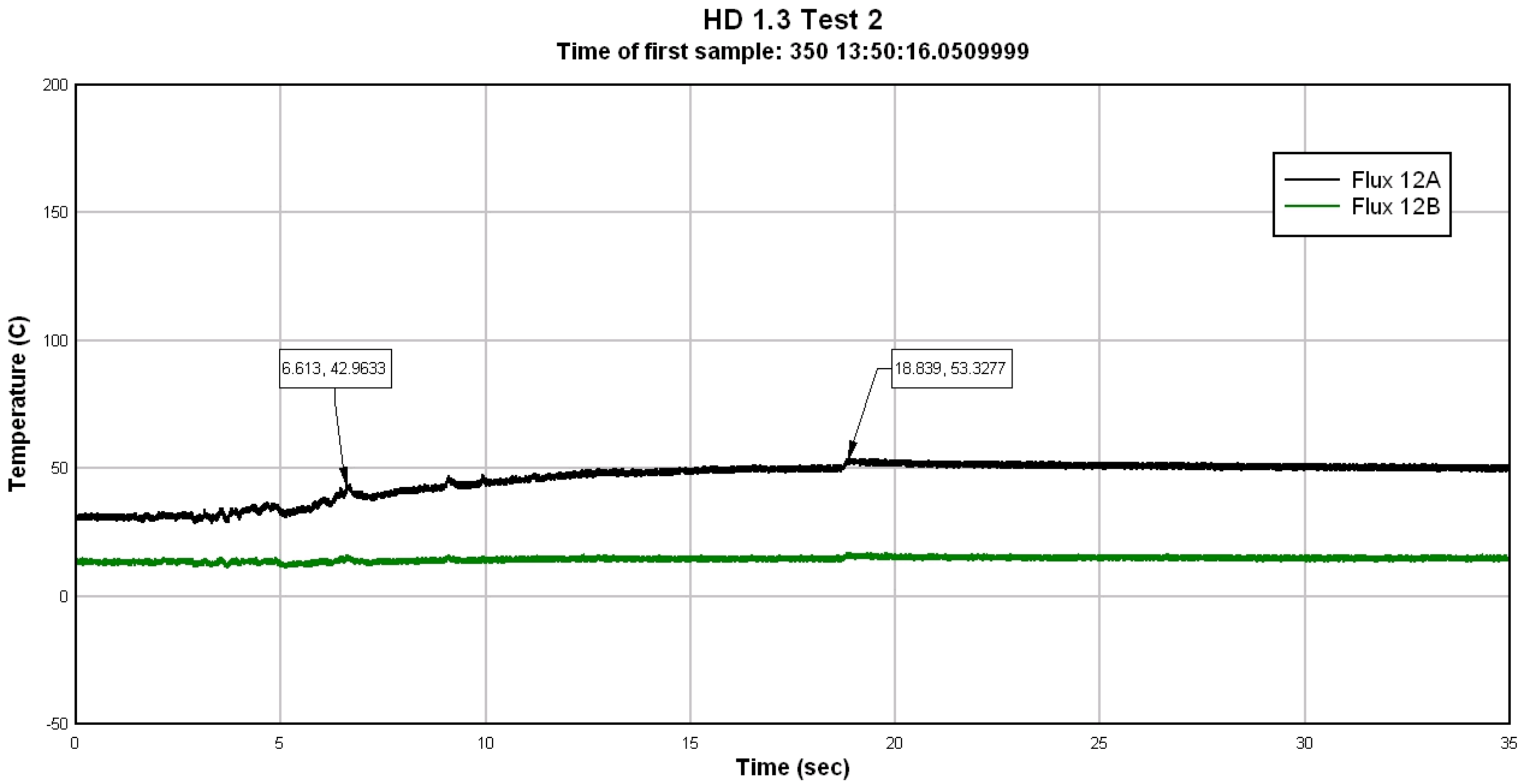

FIGURE III-C-35. Flux Gage #12A and 12B (Outside).

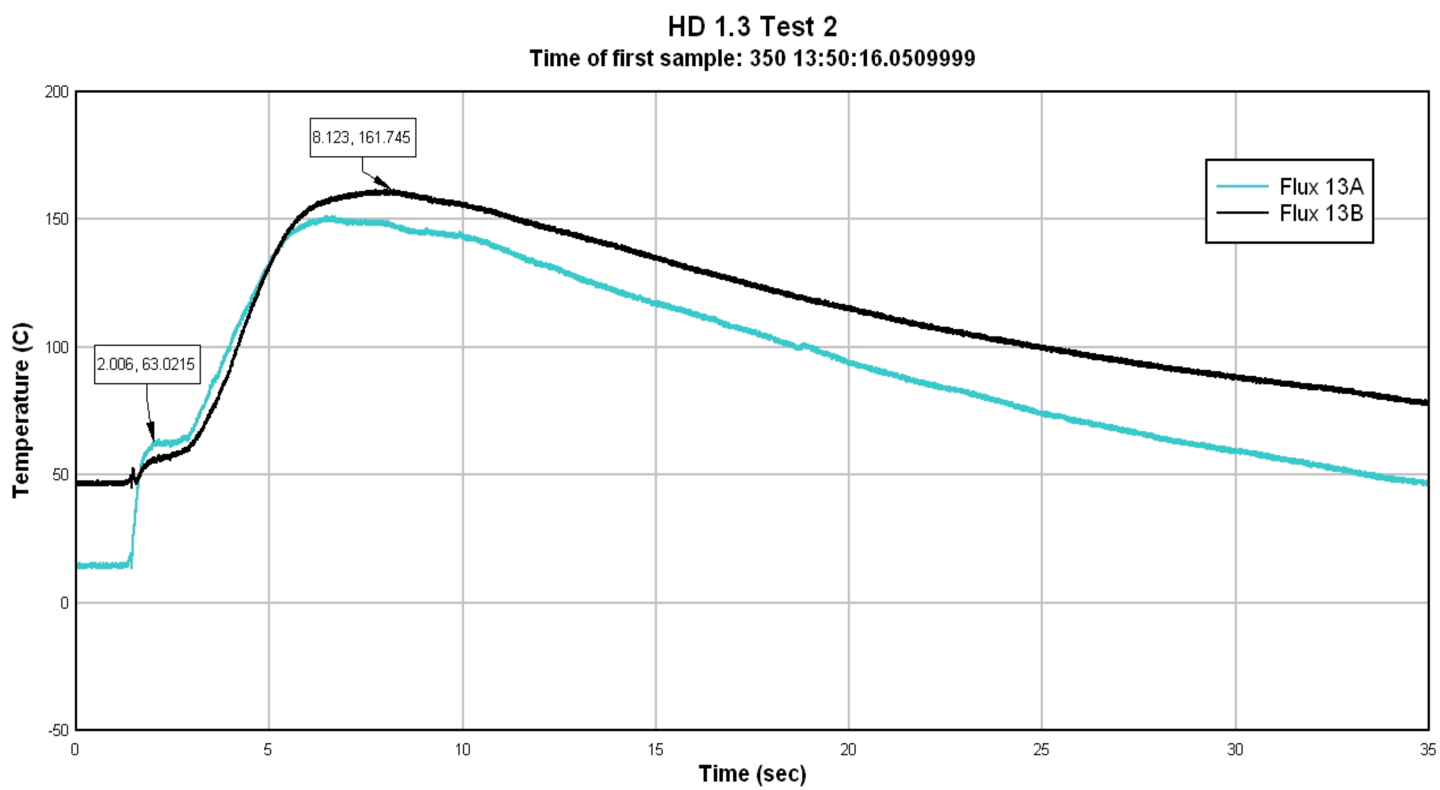

FIGURE III-C-36. Flux Gage #13A and 13B (Outside).

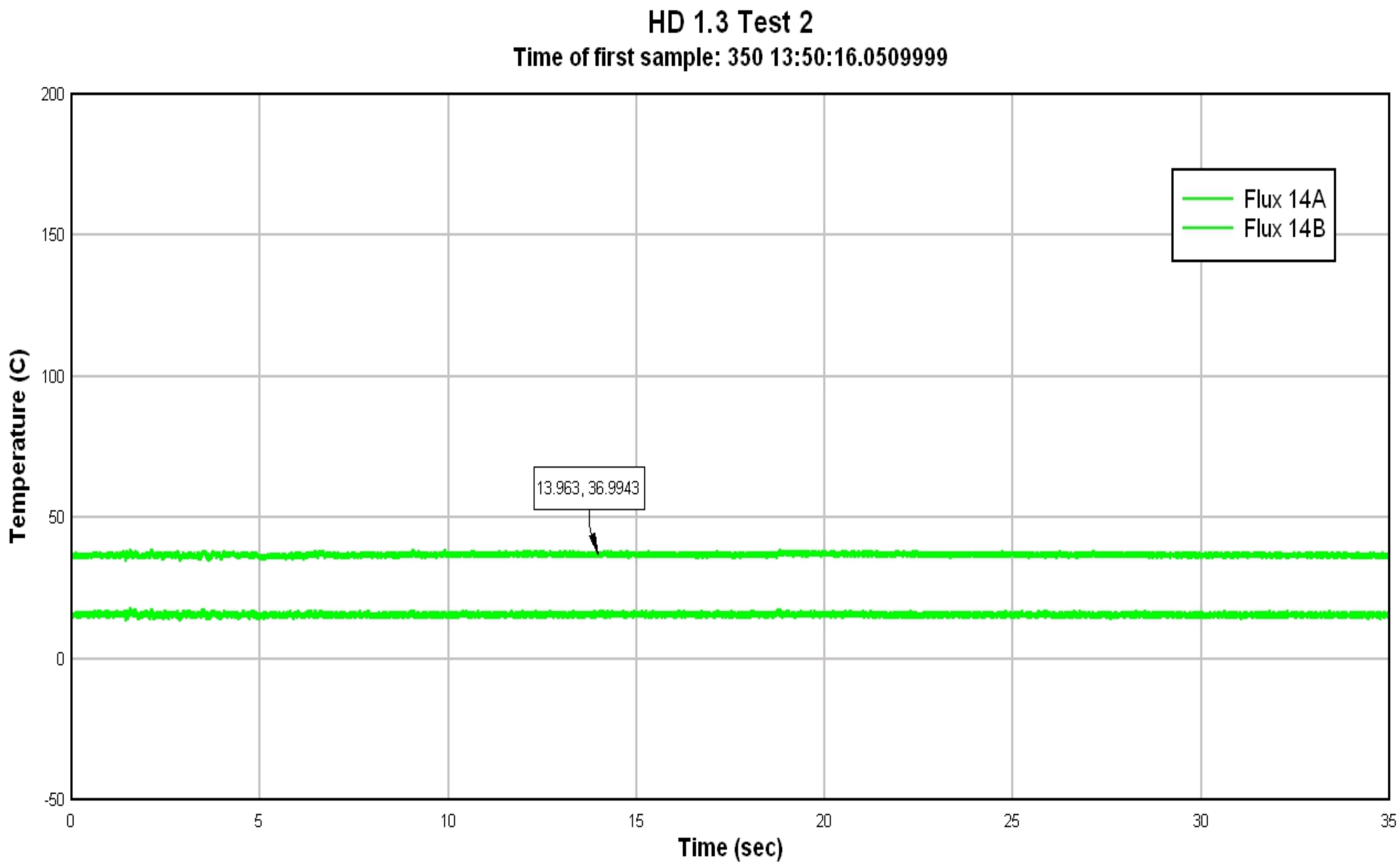

FIGURE III-C-37. Flux Gage #14A and 14B (Outside).

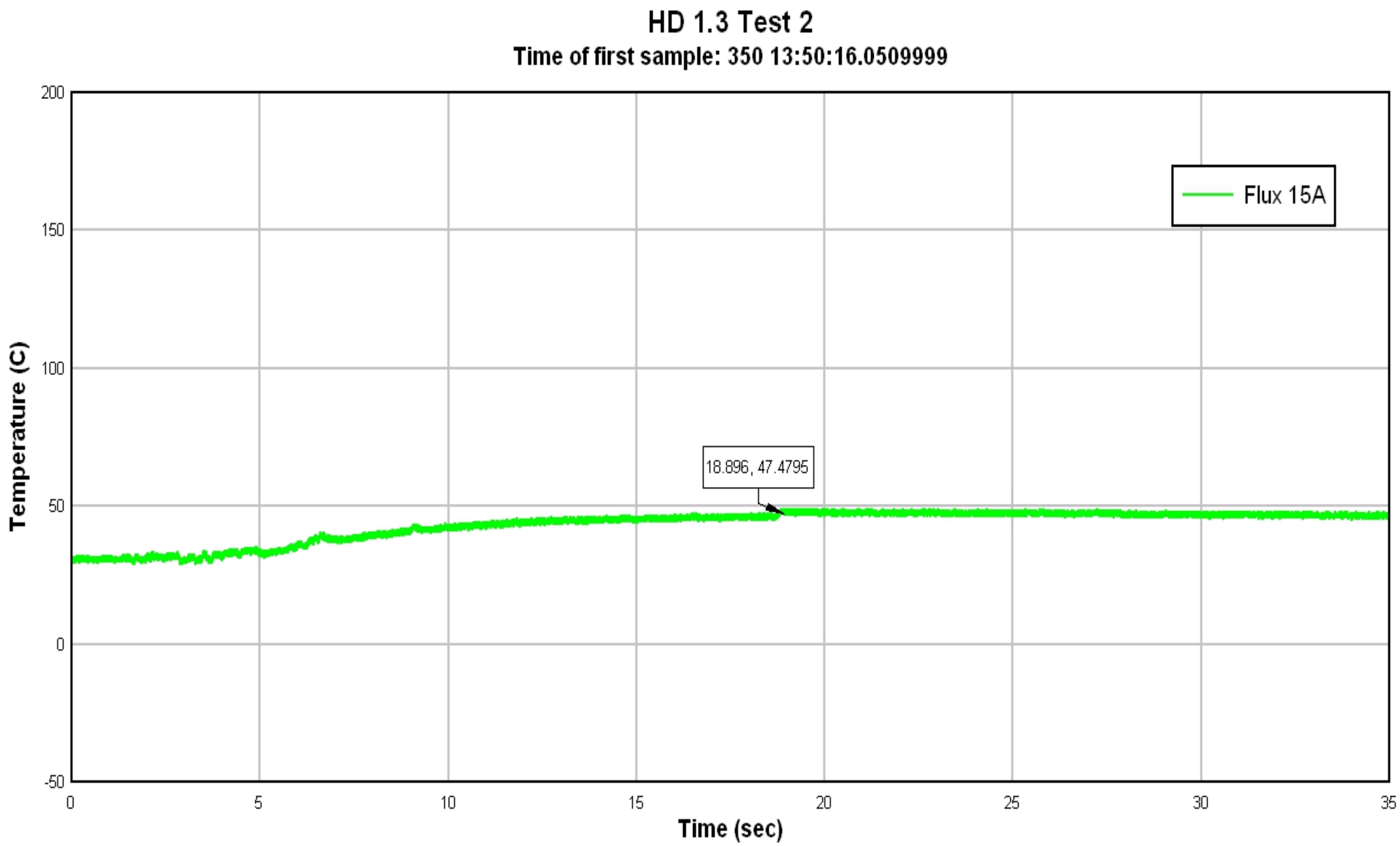

FIGURE III-C-38. Flux Gage #15A (Outside).

Summary

- Peak Temperatures Inside Structure
  - Thermocouple # 17 – 1188.49C at 1.49 sec
  - 500 C at 55.04 sec Flux Gage 16A
- Peak Temperatures Outside Structure
  - 164.66C at 1.5 sec Flux Gage 5A

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THERMAL FLUX DATA INTERNAL AND EXTERNAL TO THE STRUCTURE

Explanation of the Sensitivity study

- Based on the recording speed of the DAQ system the data was delaminated with an average of 250 and 1000 pts
  - Providing a data point per second or 4 pts per second
  - No the difference in the magnitude and location of the plots was minimal.
  - Decided to use cleanest plot for each DFT measurement

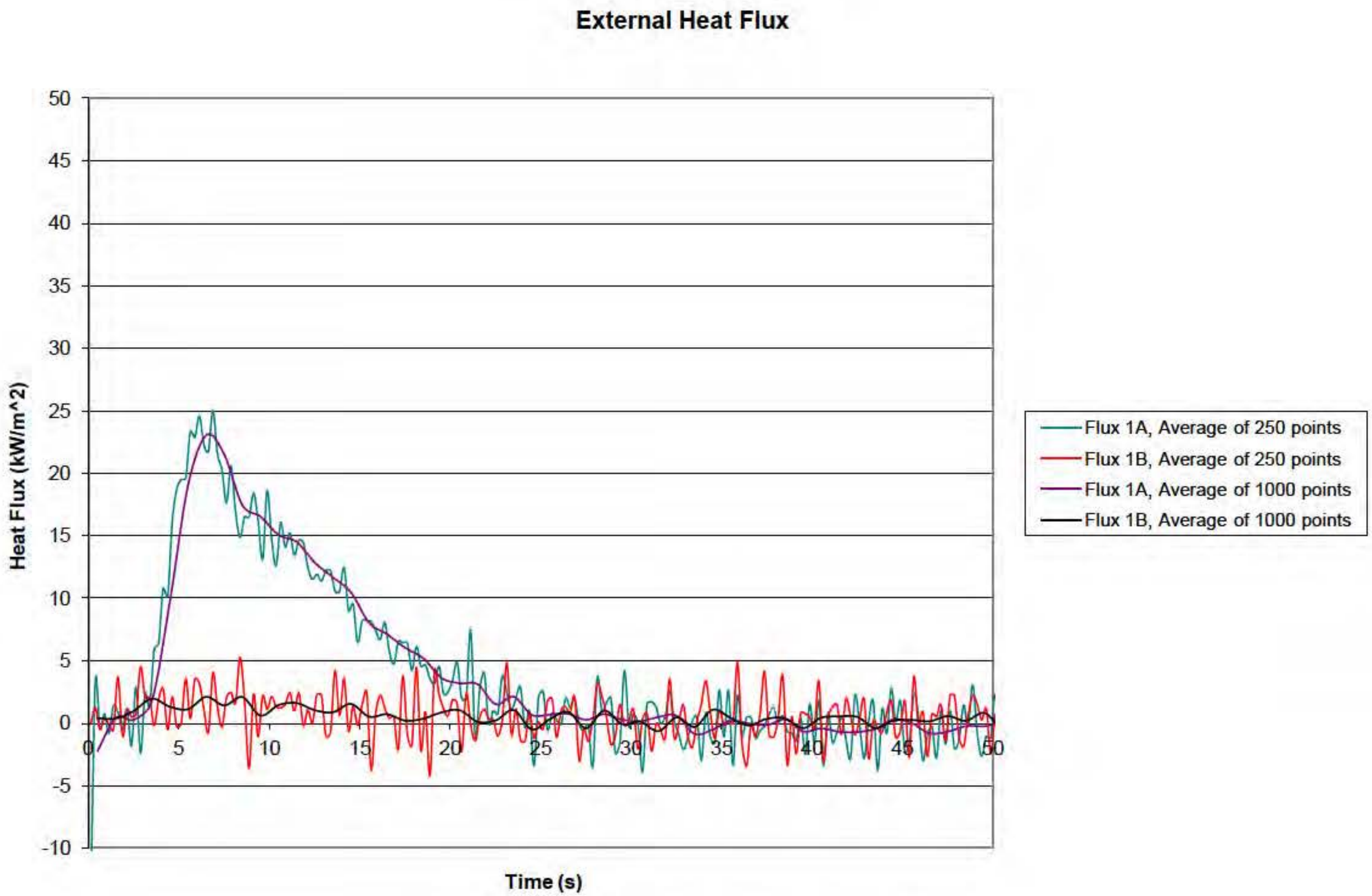


FIGURE III-C-39. Sensitivity Study.

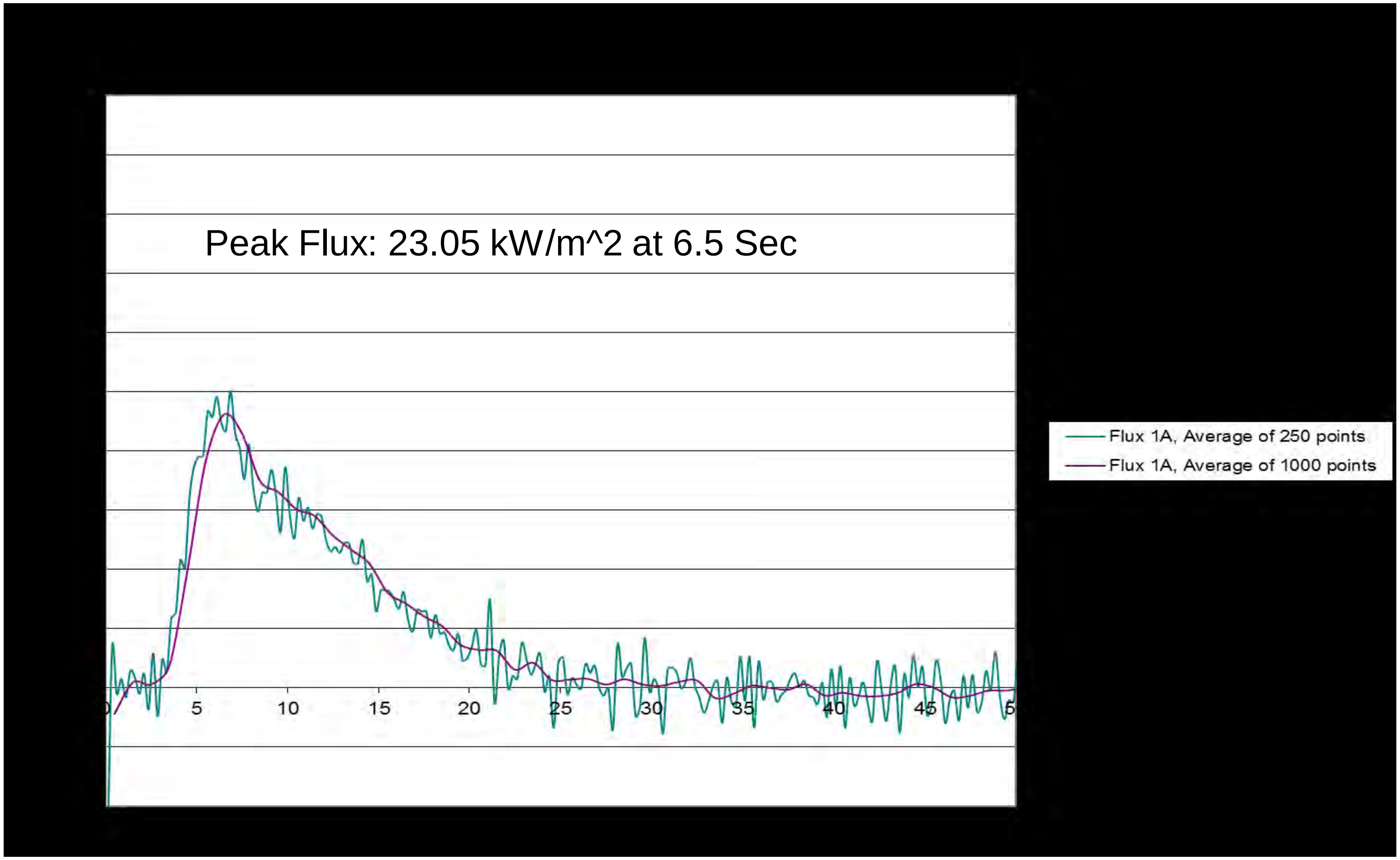


FIGURE III-C-40. Heat Flux Gages #1A, Front Face.

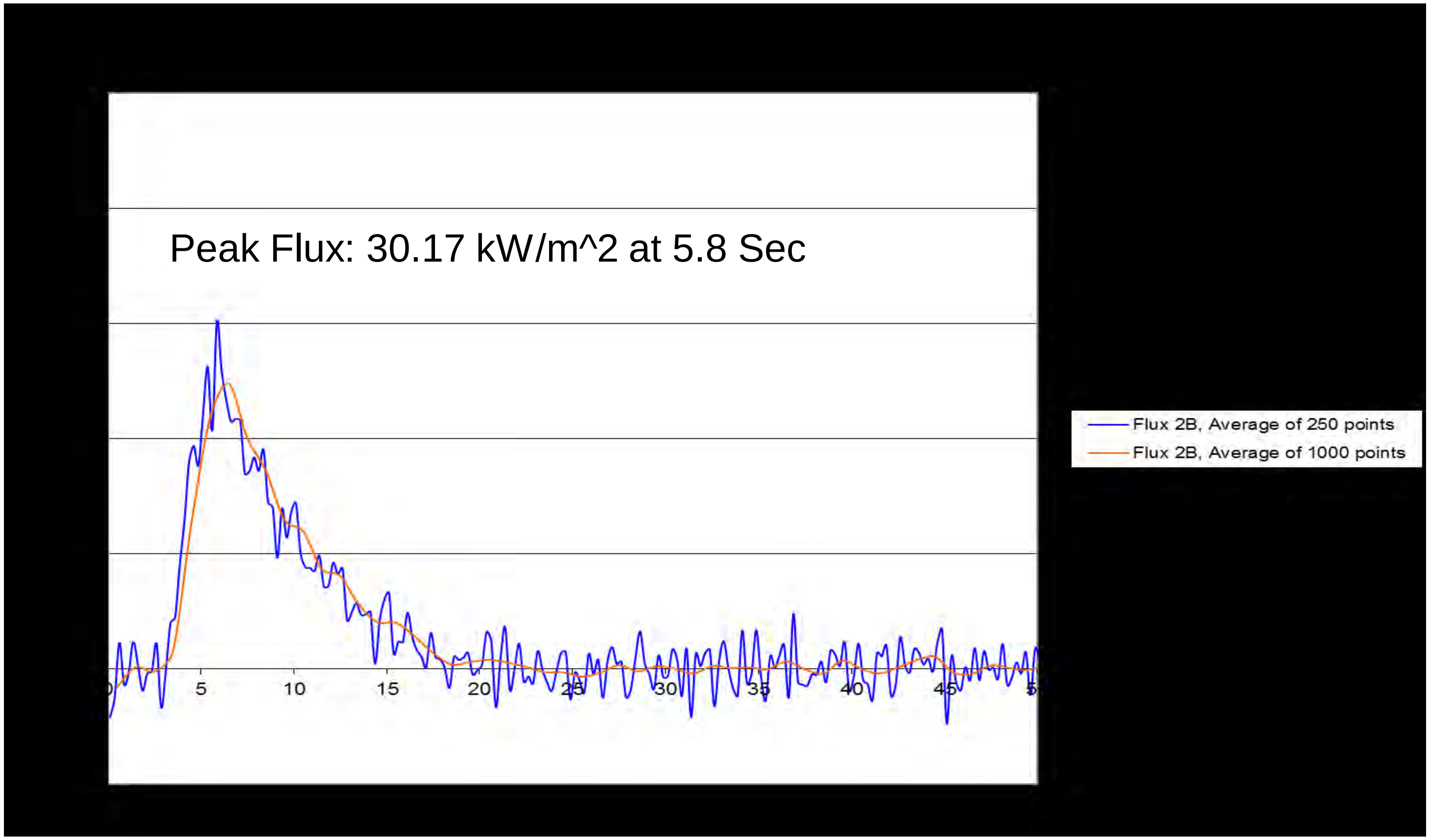


FIGURE III-C-41. Heat Flux Gages #2B, Front Face.

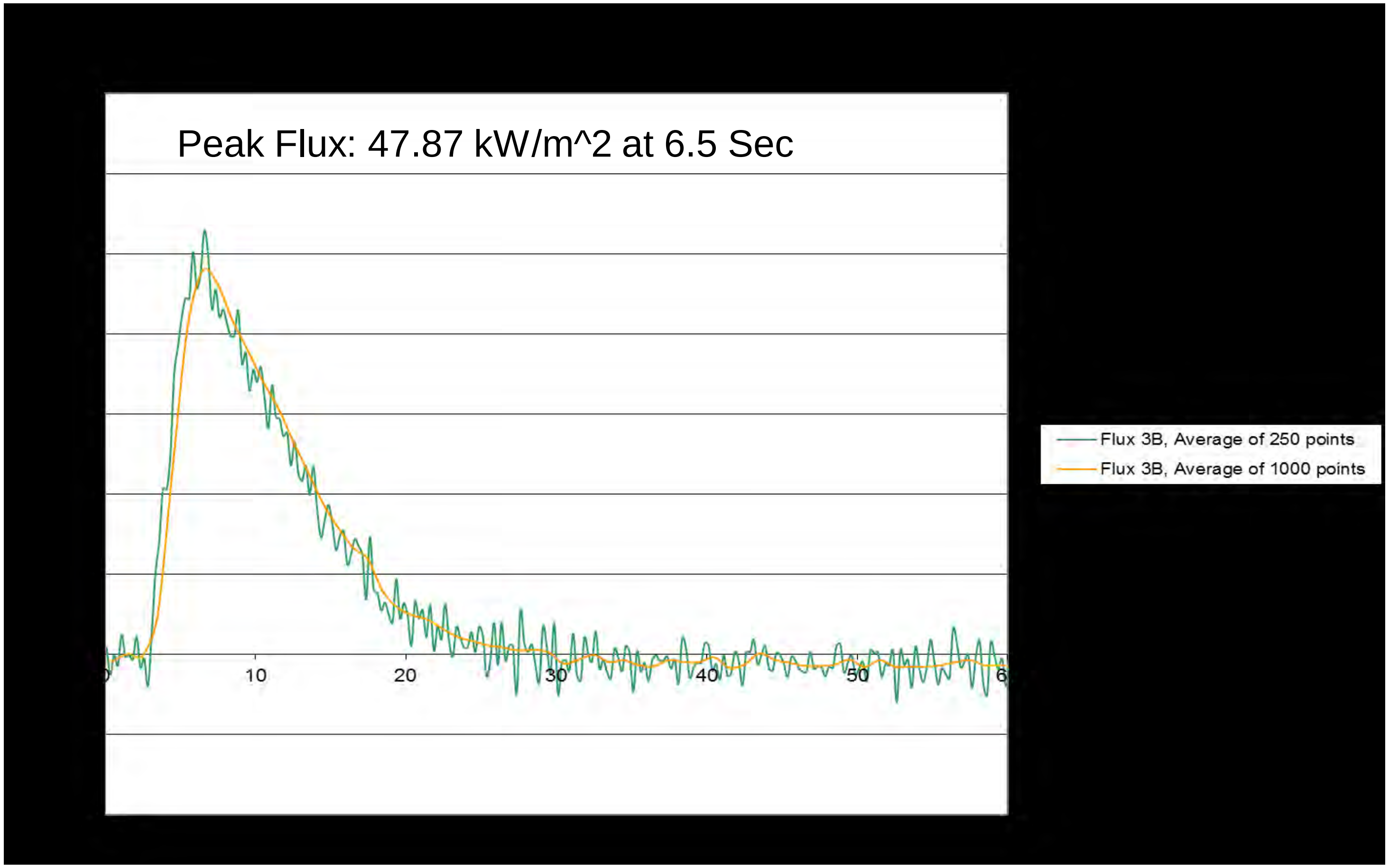


FIGURE III-C-42. Heat Flux Gages #3B, Front Face.

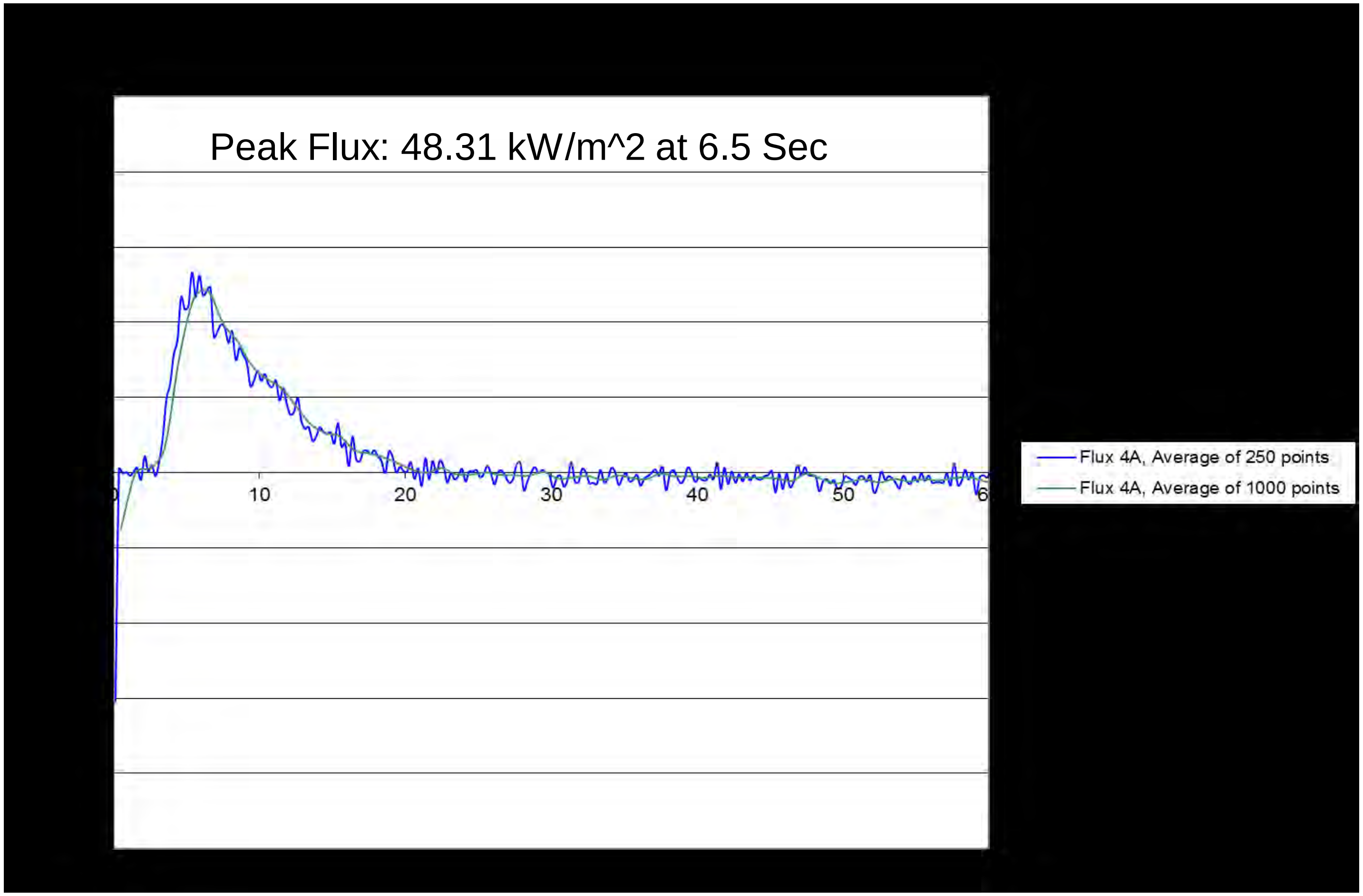


FIGURE III-C-43. Heat Flux Gages #4A, Front Face.

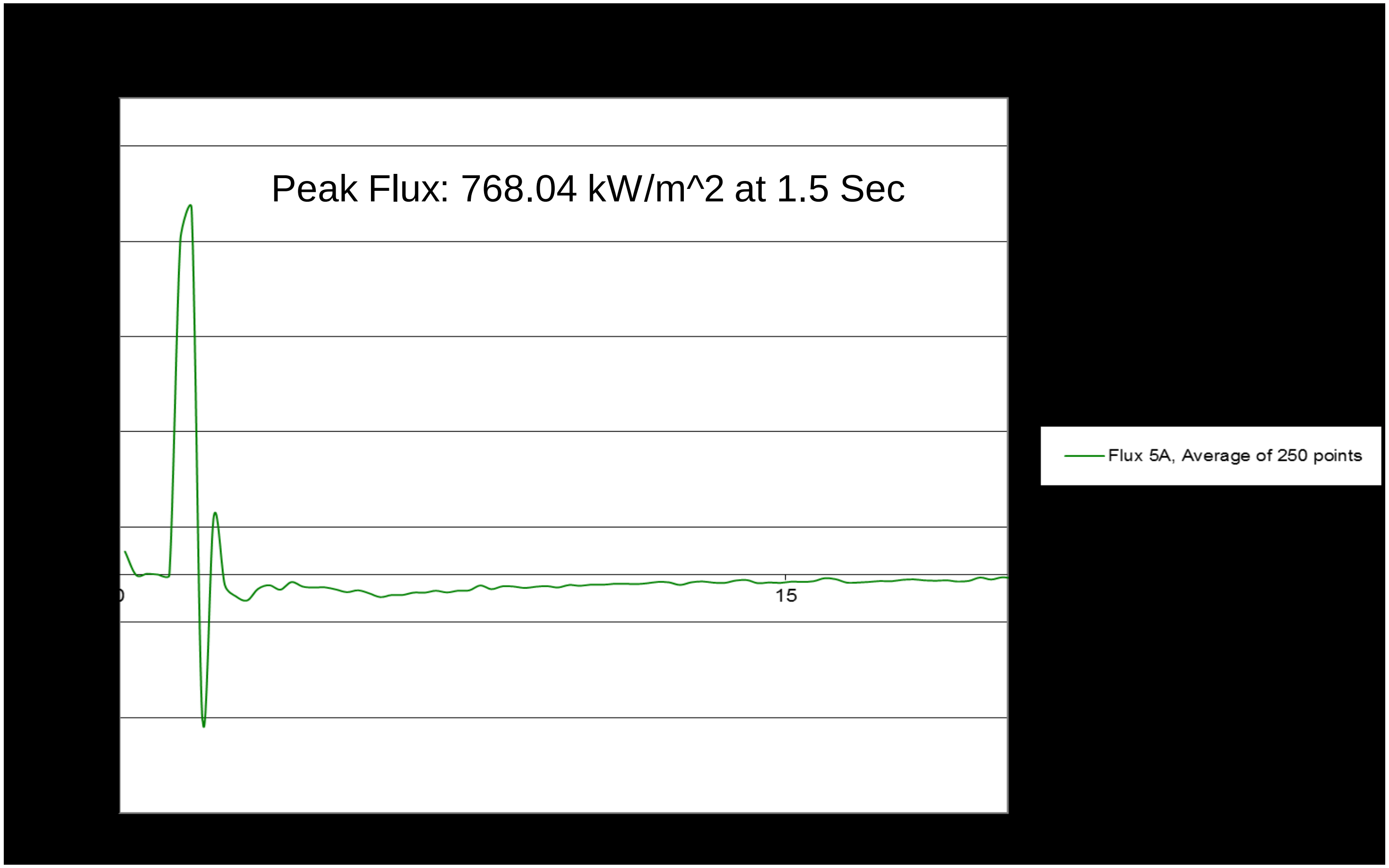


FIGURE III-C-44. Heat Flux Gages #5A, Front Face.

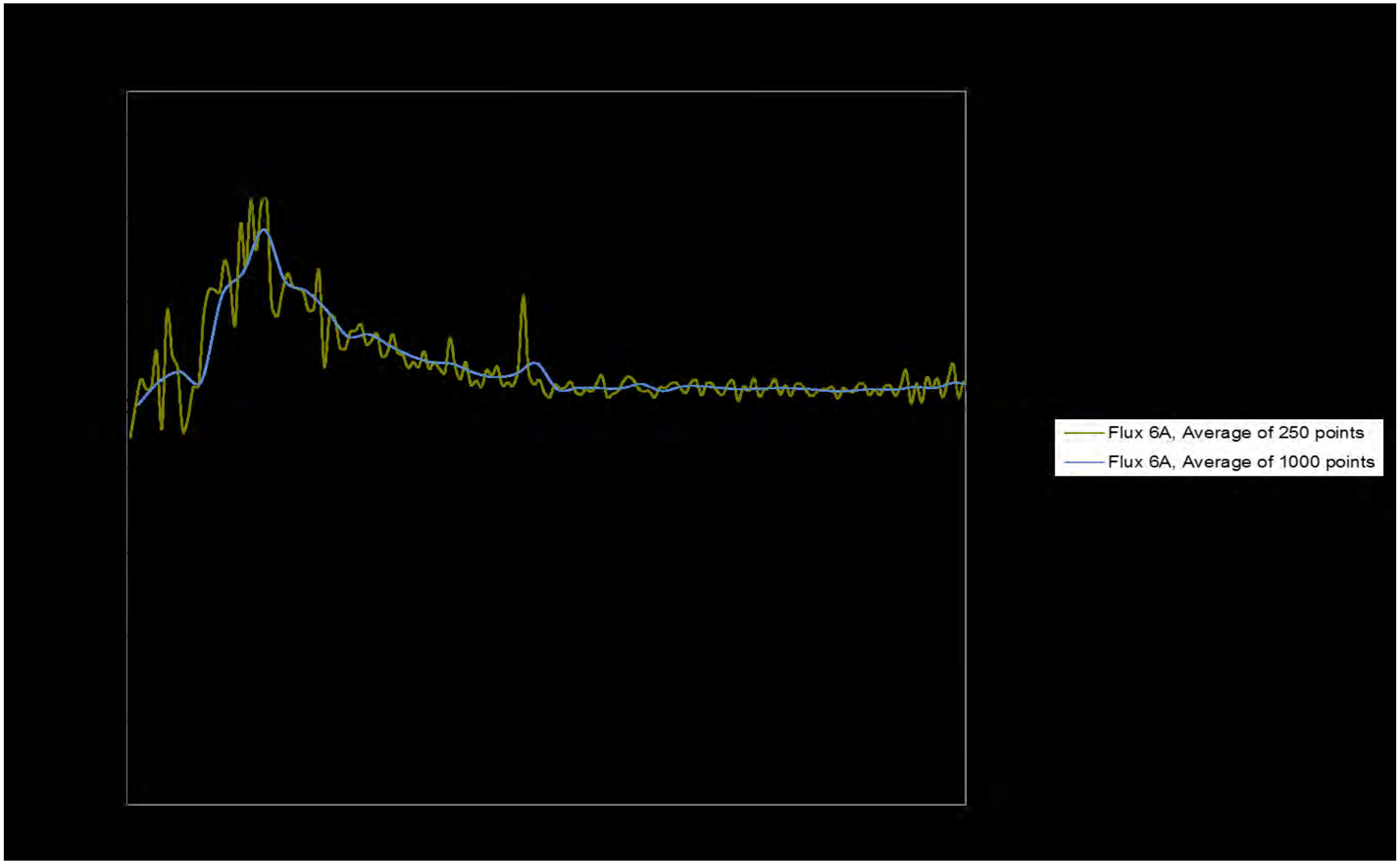


FIGURE III-C-45. Heat Flux Gages #6A, Front Face.

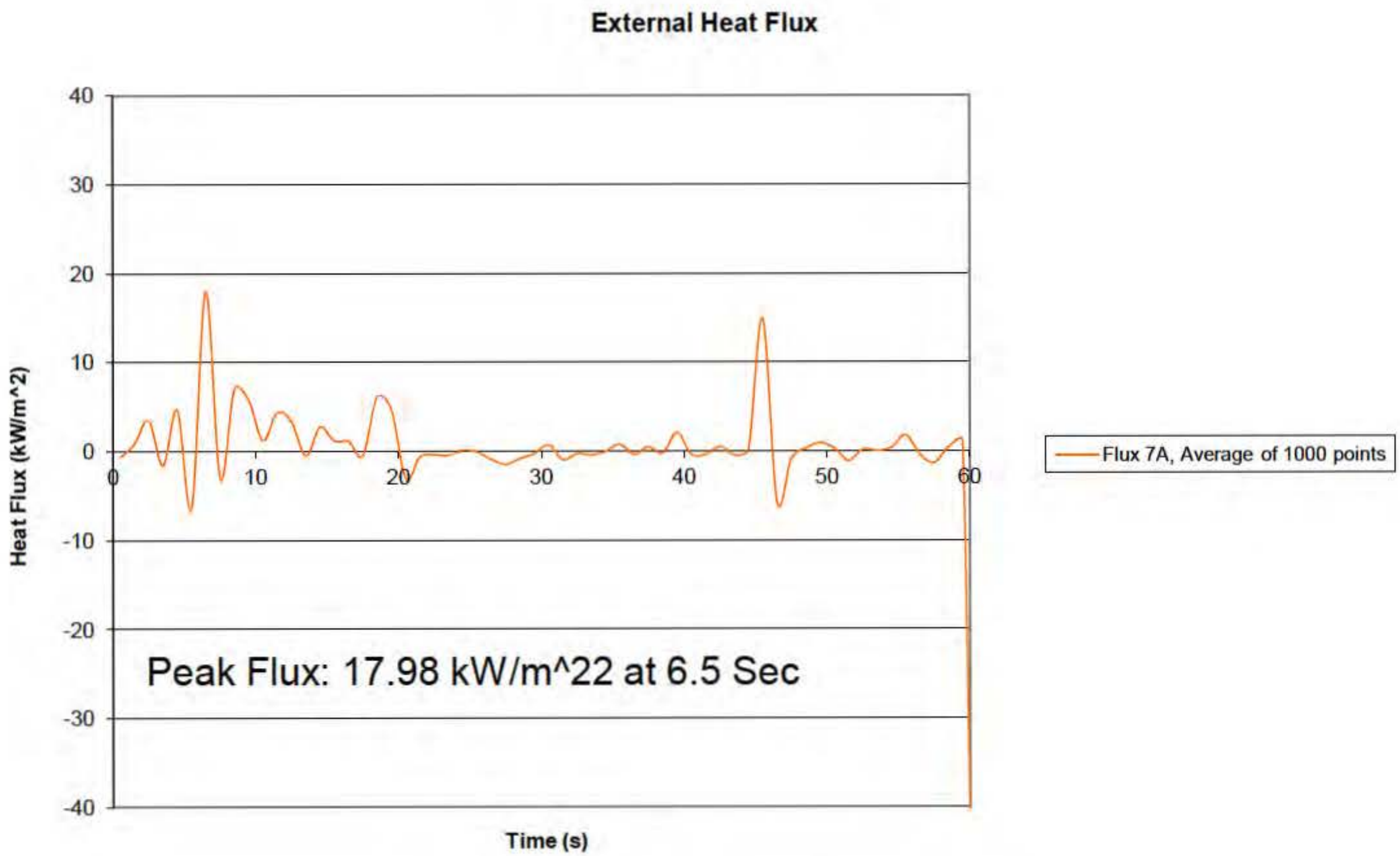


FIGURE III-C-46. Heat Flux Gages #7A, Front Face.

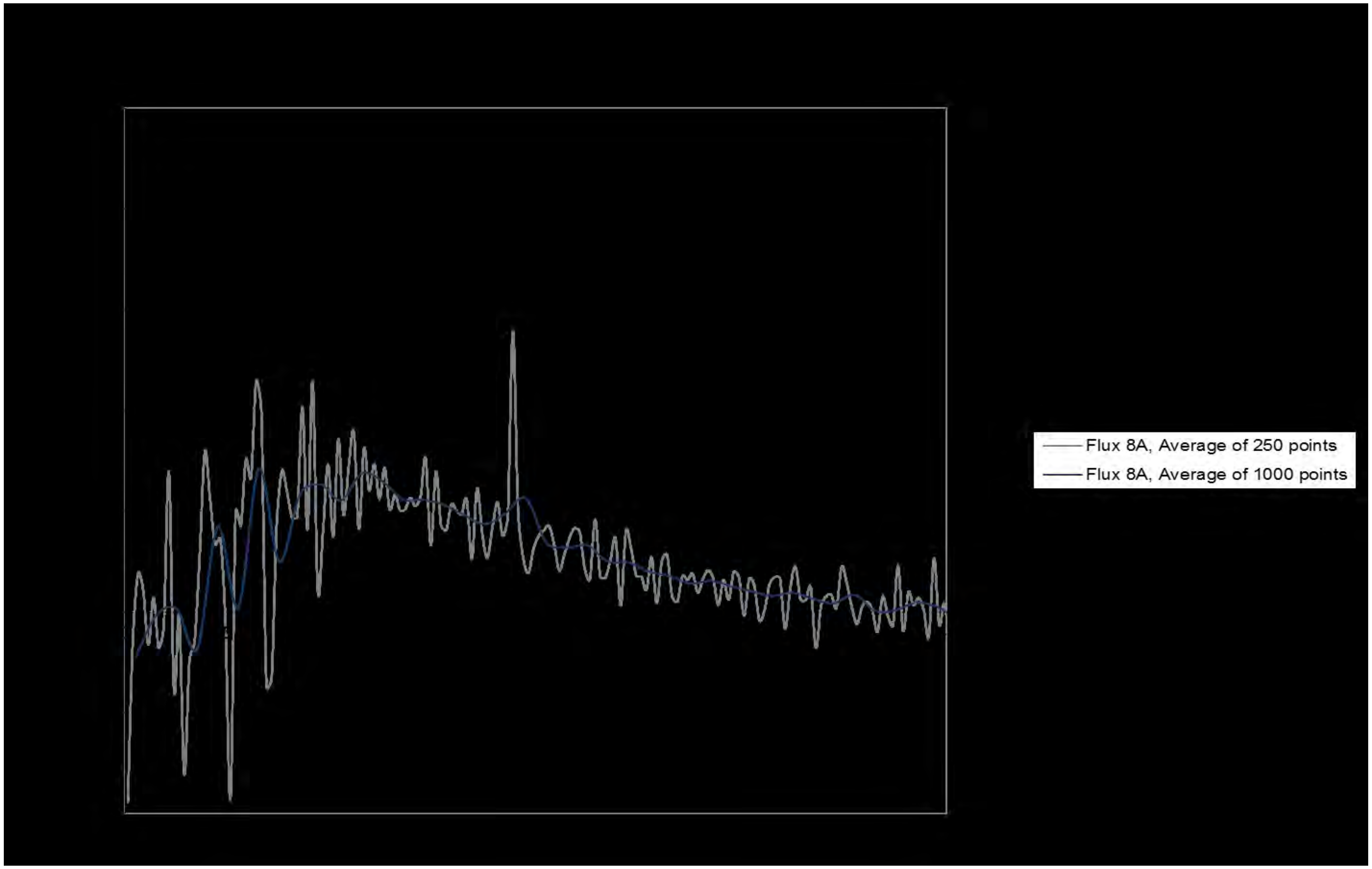


FIGURE III-C-47. Heat Flux Gages #8A, Front Face.

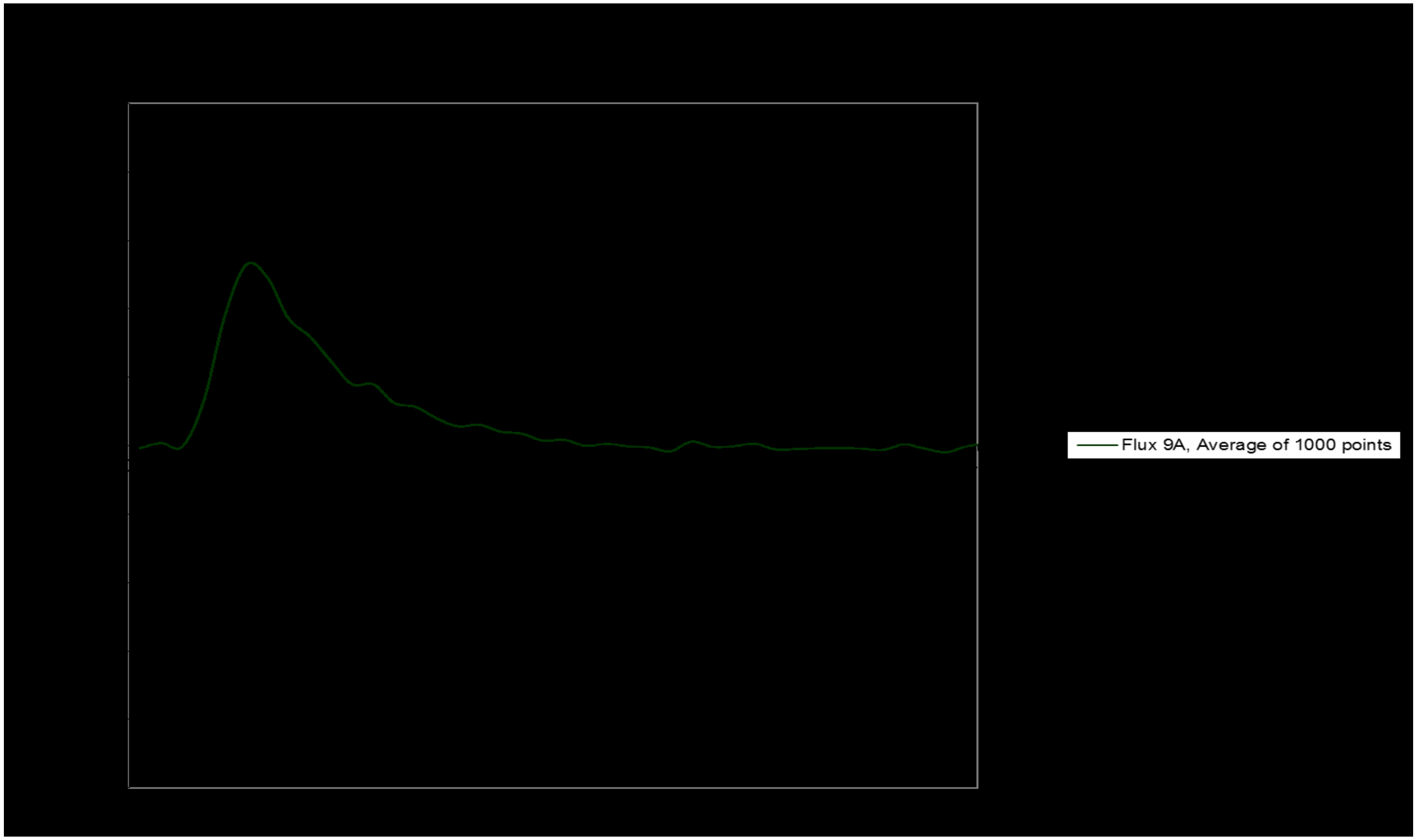


FIGURE III-C-48. Heat Flux Gages #9A, Front Face.

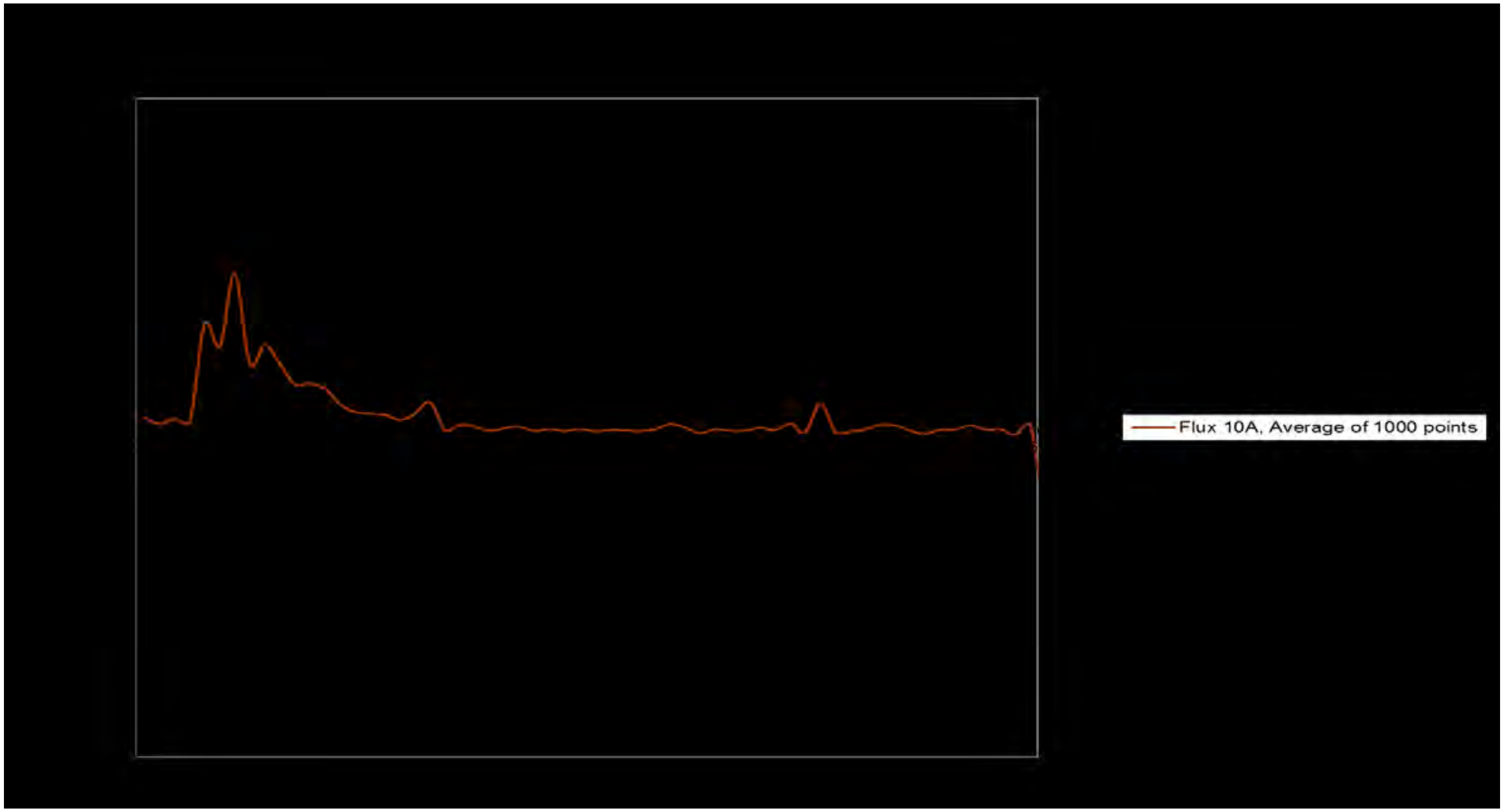


FIGURE III-C-49. Heat Flux Gages #10A, Front Face.

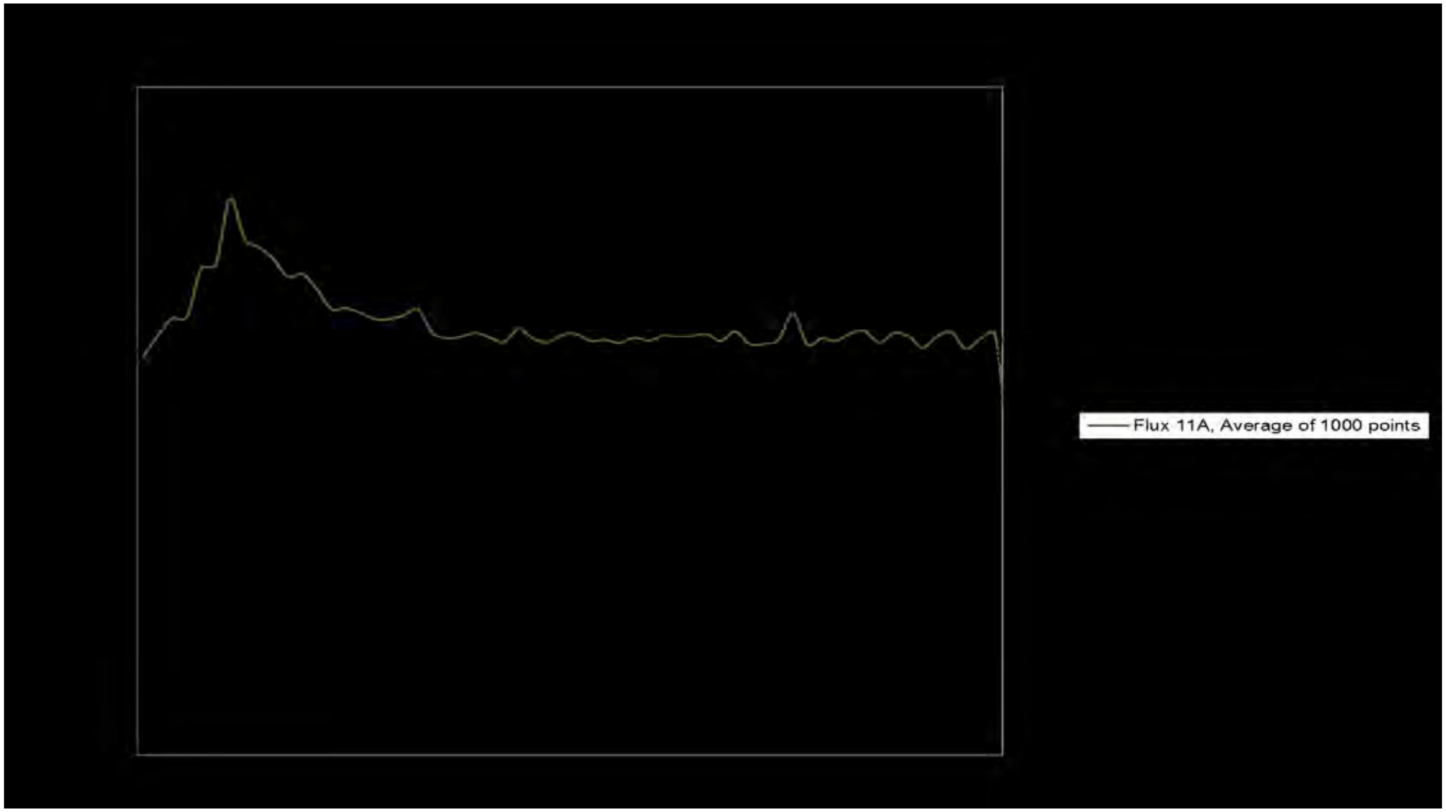


FIGURE III-C-50. Heat Flux Gages #11A, Front Face.

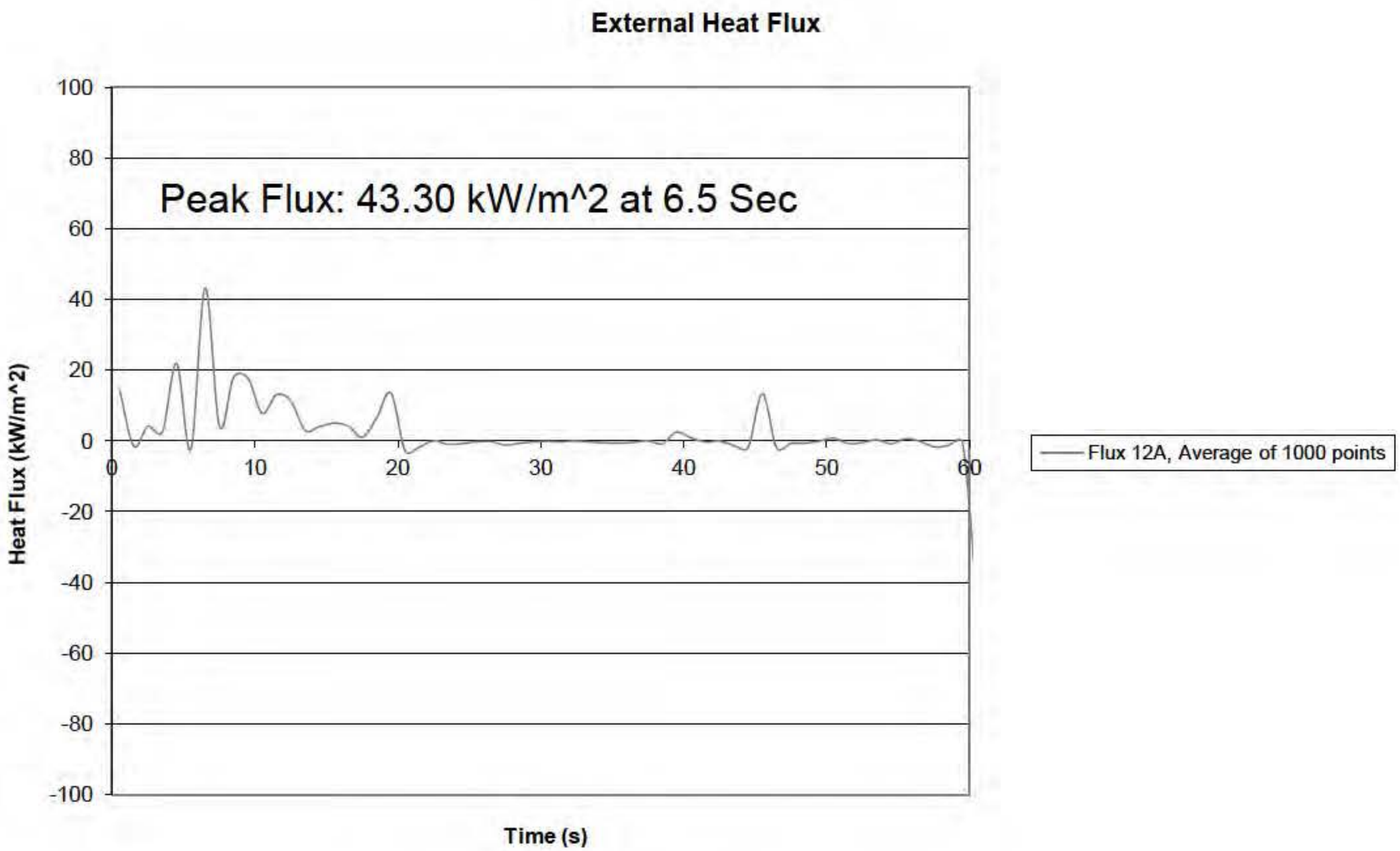


FIGURE III-C-51. Heat Flux Gages #12A, Front Face.

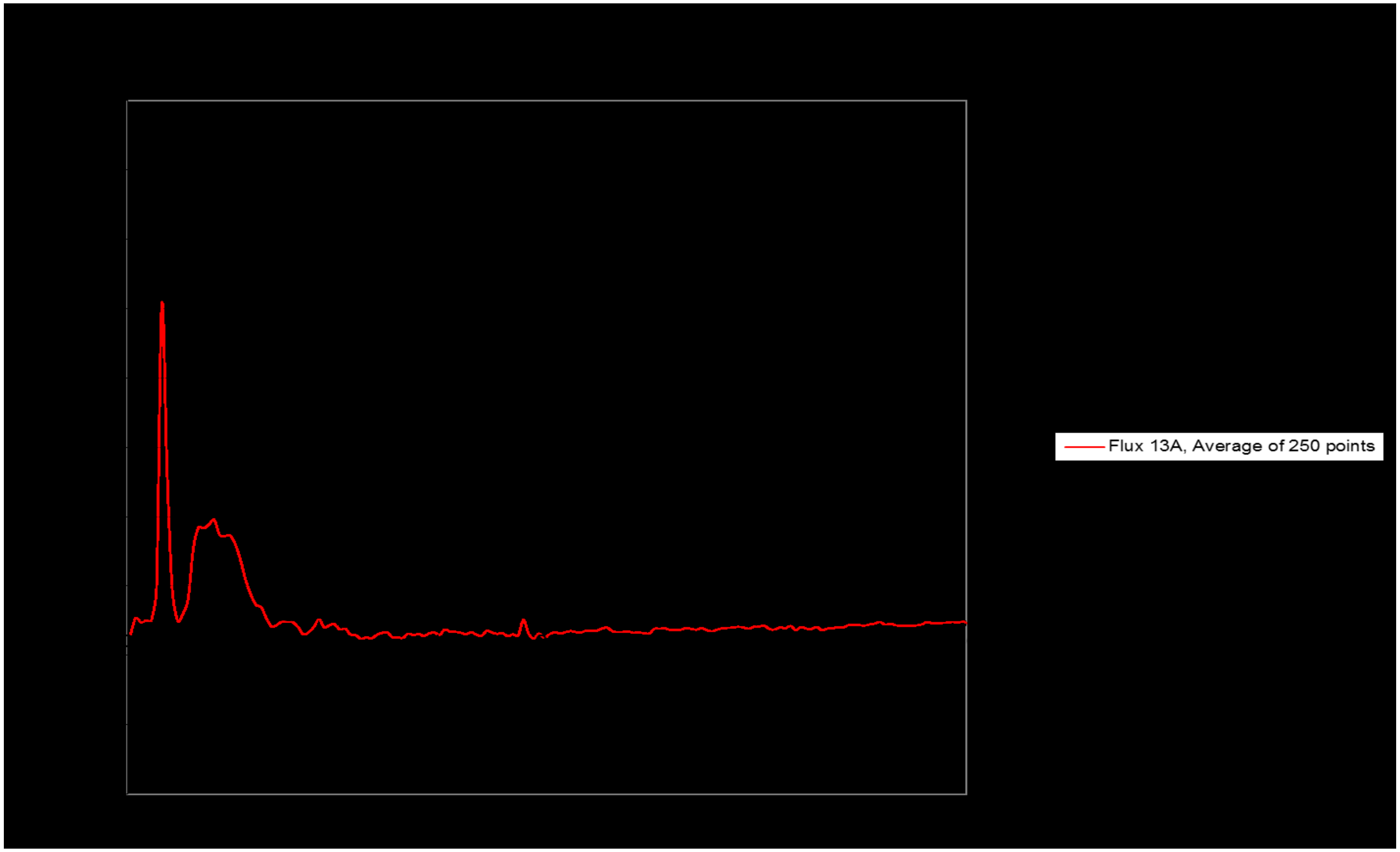


FIGURE III-C-52. Heat Flux Gages #13A, Front Face.

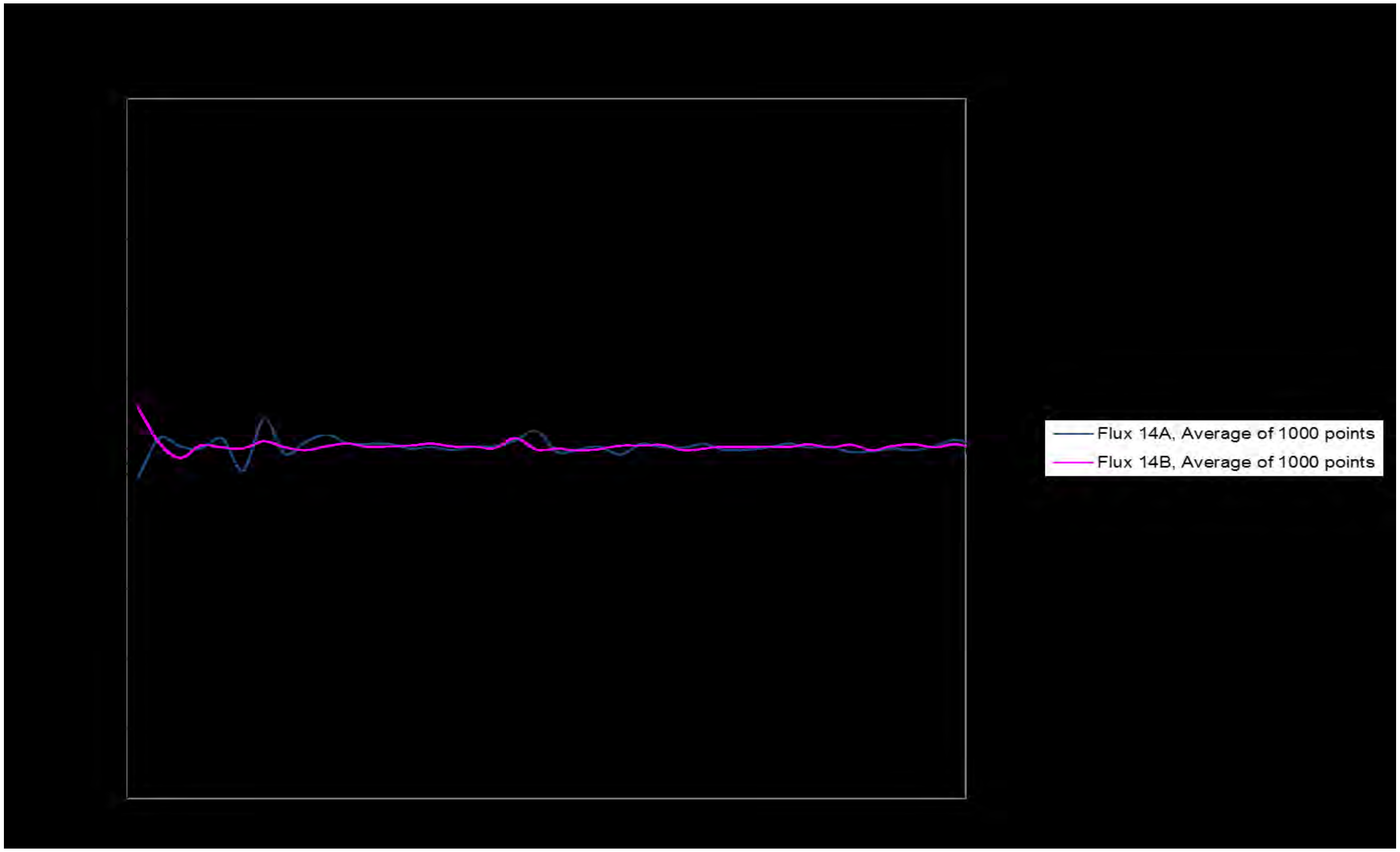


FIGURE III-C-53. Heat Flux Gages #14A and 14B.

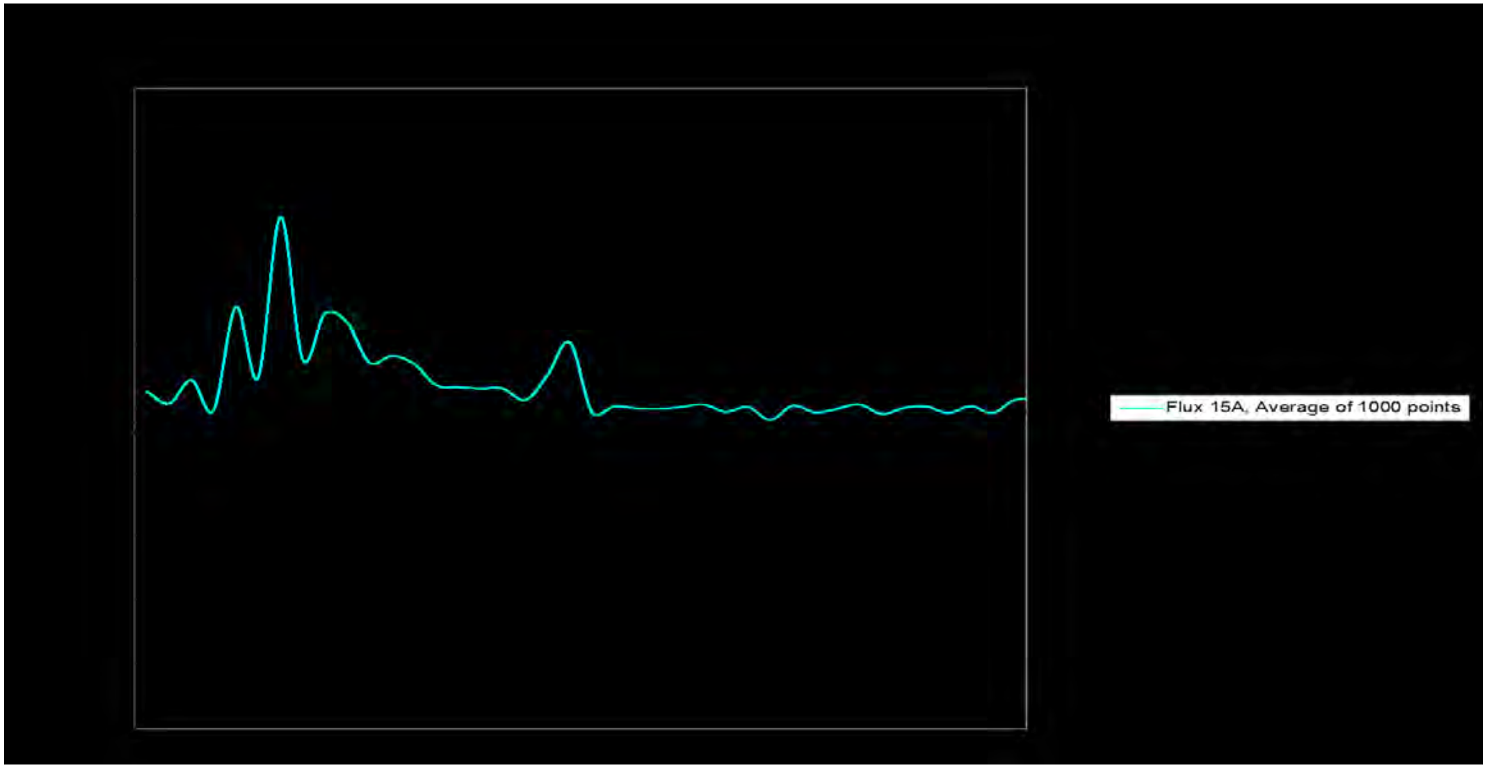
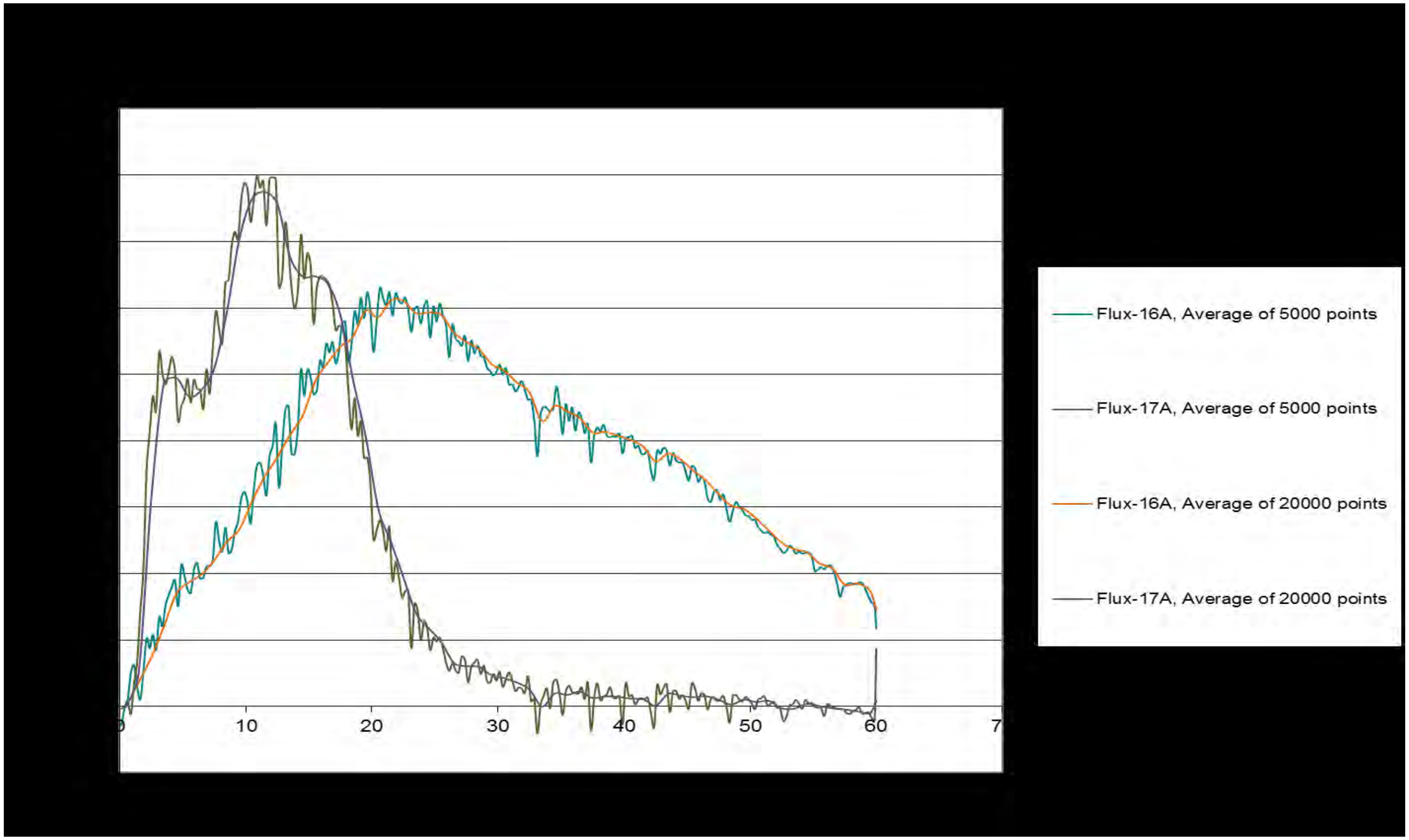


FIGURE III-C-54. Heat Flux Gages #15A, Front Face.



Peak Flux 17: 158.22 kW/m^2 at 11.38 Sec

Peak Flux 16: 122.14 kW/m^2 at 22.5 Sec

FIGURE III-C-55. Internal Flux Gages #16A and 17A.

Summary

- Peak Flux Inside Structure
  - DFT #16 – 122.14 kW/m^2 at 22.50 sec
  - DFT #17 – 158.22 kW/m^2 at 11.38 sec
- Peak Flux Outside Structure
  - DFT #13 – 913.31kW/m^2 at 1.62 sec (15 ft)
  - DFT #5 – 768.04 kW/m^2 at 1.5 sec (32 ft)
  - DFT #4 – 48.31 kW/m^2 at 6.5sec (32 ft, 48ft west of centerline)
  - DFT# 3 – 47.87 kW/m^2 at 6.5 sec (15 ft, 48ft west of centerline)

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Appendix III-D

HD1.3 TEST 2. DETAILED TIMELINE

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The following is a compilation of events seen in four high-speed videos taken of Test 2. The video cameras were northeast, southeast, southwest, and northwest relative to the structure. The designation N/roof indicates the north wall/roof intersection or joint. Similarly, S/E indicates the south wall and east wall junction.

TABLE III-D-1. Detailed Time Line of Test 2.

IRIG	Time	Delta t	Camera	Event
13.510.	2.085575	0	NE	First indication of flamelet in structure
13.51.0	2.112294	0.027419	NW	First light in Kasun structure
	2.118388	0.032813	NE	Flamelet had disappeared, now reappeared
	2.123075	0.037500	NE	Flame seen at bottom of orifice but still inside structure
	2.132607	0.047032	NW	Light visible
	2.154182	0.068607	NW	Flamelet
	2.160731	0.075156	NW	First flameout out orifice
	2.165262	0.079687	NE	Flame fully developed in structure
	2.302763	0.217188	NE	Flamelet out of orifice
	2.366825	0.281250	NE	Unsteady flamelet up until now; flamelet grows from this time
	2.374793	0.289218	NW	Puny plume 3.8 ft. out vent
	2.454481	0.368906	NW	Plume rapidly expanding
	2.635572	0.549997	NE	Plume diam ~diam of orifice
	2.716981	0.631406	NW	Smoke vicinity of N/roof
	2.721513	0.635938	NE	Good robust plume
	2.727919	0.642344	NW	Smoke venting W/roof
	2.746200	0.660625	NE	Start to smoke from roof
	2.759169	0.673594	NW	Smoke S/W wall joint
	2.773321	0.687746	NW	Door begins to bow. Smoke out center edge of door
	2.785263	0.699688	NE	Smoke at front and rear of roof

TABLE III-D-1. Contd.

IRIG	Time	Delta t	Camera	Event
				Plume diam larger than orifice diam
	2.834637	0.749062	SE	Plume fully developed
				Smoke from roof/N wall
	2.838857	0.753282	SW	Smoke mid W/roof
				Plume fully established
	2.839325	0.753750	SE	Roof starting to bow
	2.839950	0.754375	NE	Smoke at E/roof, N/roof, W/roof, E/S wall joints
				Really robust plume ~2X orifice diam
	2.841200	0.755625	NW	Gap between wall & top of door
	2.847450	0.761875	NW	Smoke out roof
				Still have visible plume
				Flame visible NE corner door
	2.848232	0.762657	SW	Roof rising
				More smoke w/roof
	2.850263	0.764688	SE	Roof/N wall smoke
	2.851357	0.765782	SW	Roof rising
				More smoke at S/roof joint
				Smoke WS joint
	2.851826	0.766251	SE	N part of roof rising
				Plume still robust
	2.856045	0.770470	SW	Smoke W/roof and N/roof joints
				Smoke S/roof
	2.856513	0.770938	SE	Rupture of roof/N wall with smoke and flame
	2.856825	0.771250	NW	Flame visible mid W/roof

TABLE III-D-1. Contd.

IRIG	Time	Delta t	Camera	Event
				Walls starting to distort
				Door-wall gap expanding at top
	2.857137	0.771562	NE	Flame top of door on E side
				Flame seen through smoke on roof
				Appears door separated from N wall
				Plume very robust
	2.857607	0.772032	SW	Flames W/roof joint and N/roof joint
	2.858076	0.772501	SE	N roof rising, flame and smoke from roof/N wall
				Smoke from S wall near roof
				Small amount of smoke at S/E joint and S/W joint
				Roof separating from E & W walls evidenced by smoke
				Plume still robust past edge of picture
	2.858387	0.772812	NW	Causes flame to move downward
				Still visible plume out orifice
	2.858699	0.773124	NE	Flame out top of door on E side
				Flame out W/roof joint
	2.859170	0.773595	SW	Fireball W/roof joint and N/roof joint
	2.859638	0.774063	SE	Roof rising and separating from E & W walls
				Flame out front and W
				Plume still robust
	2.859950	0.774375	NW	Top of door moving out
				Expanding fire at NE and W
				Fireballs E/roof and W/roof

TABLE III-D-1. Contd.

IRIG	Time	Delta t	Camera	Event
	2.860732	0.775157	SW	N and W fireballs merge, roof rise
				More smoke S/roof joint
	2.861825	0.776250	NE	Significant flame/fireball W/roof
				Flame upper door E side
				Smoke E/roof
				Plume started to deflect down as door coming off at top
	2.863857	0.778282	SW	Fireballs expand
	2.864637	0.779062	NW	Top of door moving out
				Plume still visible but significantly less
	2.864950	0.779375	NE	Fire ball above roof mostly on W side
				Fire out top & E center of door
				Smoke E/roof
				Door still fastened at bottom
	2.865888	0.780313	SE	Roof continuing to rise with flame out front and W
				Smoke on upper S wall indicates coming apart at internal joint
				Smoke at S/W wall joint
	2.866513	0.780938	NE	Fireball upper part of door
				Big fireball above roof
				Still plume out orifice
	2.866982	0.781407	SW	Fireballs expand, roof rises
				Smoke SW joint and S/roof joint
	2.867450	0.781875	SE	Front of roof lifting off
				Large fireball on W & N

TABLE III-D-1. Contd.

IRIG	Time	Delta t	Camera	Event
				Plume appearing to thin but still past edge of picture
	2.867762	0.782187	NW	Fire balls at top of door, E/roof, mid W/roof
				Last traces of plume
	2.869325	0.783750	NW	Huge fireball engulf structure
	2.870576	0.785001	SE	Roof continuing to lift with large fireball out front
				Plume diminishing & thin
	2.871667	0.786092	SW	Larger fireballs, plume breaking up
	2.872139	0.786564	SE	More of above but plume replaced by fireball
				SE joint hardly damaged
				Roof almost entirely detached from N, E, & W walls
	2.872753	0.787178	NE	Large fireballs upper door and above roof
				Smoke E/roof
				Losing plume from orifice
	2.873701	0.788126	SE	Fireball in NW quadrant
				Plume extends out of fireball
	2.875264	0.789689	SE	Roof continuing to rise. Can still see grid pattern on roof
				Roof
				Plume diminished in length
	2.876826	0.791251	SE	Roof at ~ 30-40 degrees from horizontal
				Fireball in NW quadrant
				Plume still extending from fireball
	2.877917	0.792342	SW	Larger fireballs, Plume weird
	2.878389	0.792814	SE	Large fireball. Appears roof and door directing

TABLE III-D-1. Contd.

IRIG	Time	Delta t	Camera	Event
				Direction and location of fireball
	2.878700	0.793125	NW	N and W walls splayed out
	2.879951	0.794376	SE	No fire on S or E sides
	2.881513	0.795938	SE	Roof @ ~45 Large fireball NW quadrant
	2.884638	0.799063	SE	Expansion of fireball. No plume per se
				Fireball in NW quadrant
				Roof only attached at S wall
	2.885730	0.800155		Just two big merged fireballs
				Roof @ 45 degrees from horizontal
				No plume
				Big smoke from E/roof joint
				Smoke from S/roof joint
	2.890887	0.805312	SE	Continued expansion of fireball
				Roof at ~ 55 degrees from horizontal
	2.893076	0.807501	NE	Very large fireball door and roof
				Smoke E/roof and S/roof
	2.893542	0.807967	SW	Fireballs expand, in NW quadrant
	2.896201	0.811045	NE	One very large fireball, flame out E/roof, no plume
	2.898699	0.813124	SE	N wall expanding out
				Door being expelled
				Roof @ ~ 60 degrees from horizontal
	2.901356	0.815781	SW	Fireball expanding, roof rising
	2.901824	0.816249	SE	Fireball continues to expand

TABLE III-D-1. Contd.

IRIG	Time	Delta t	Camera	Event
				Roof continuing to pivot with S wall being hinge
				SE joint intact
				Roof still directing largest lobe of fireball
	2.905263	0.819688	NW	First frags visible
				Huge fireball engulf structure
				Fragments in W and N areas & out top
	2.908074	0.822499	SE	Fragmentation at edges of roof
				Some fragments from N roof
	2.910263	0.824688	NE	Large fireball N wall, roof; fire out E/roof
				Door attached at bottom with top pivoting out
	2.913856	0.828281	SW	Huge fireball, roof rising, roof breaking up
	2.921199	0.835624	NE	Start to see fragments in/through fireball
	2.923232	0.837657	SW	Some fragments being formed
	2.926825	0.841250	SE	Fragmentation roof/N wall
				Upper portion of roof breaking up
				Huge fireball out NW quadrant
	2.928387	0.842812	SE	Large frags expelled from N edge of roof
	2.935732	0.850157	SW	Roof approaching vertical, breaking up
				Huge fireball out front
	2.936200	0.850625	SE	Huge fragments being accelerated
				About ½ of N part of roof being rubblized
	2.940420	0.854845	SW	Fragments formed from roof
	2.945576	0.860001	SE	Continuing rubblization of N part of roof

TABLE III-D-1. Contd.

IRIG	Time	Delta t	Camera	Event
				Rubble backlit by fireball
	2.945887	0.860312	NW	Large frags from roof/N
	2.955575	0.870000	NE	Door still attached at bottom but pivoting out @~45
				Can still see orifice
				Massive fireball, fragments
				Large fragments from N/roof area, looks like concrete
				Above door breaking into very large fragments
				Fire out roof/E
	2.956825	0.87125	NW	Huge frags going N and W
				Smaller frags going up from roof
				Big white frag w/ 2 black stripes
	2.961201	0.875626	SE	What left of roof vertical
				Door/frame falling (about 45 degrees from vertical)
				Large frags from roof & N wall traveling outward
	2.962293	0.876718	SW	As roof rotates, roof fragments, throw frags
				Break up along interior roof/S wall joint
	2.980575	0.895000	NE	Large fireball. Large frags from roof/N above door
				Door still pivoting with bottom still attached
				E wall still largely intact. S wall and W wall still intact and directing fireball outward
	3.006044	0.920469	SW	Still burning propellant in what left of structure
				W, S, E walls still standing
	3.011199	0.925624	SE	Roof well over vertical, expelling frags as it travels

TABLE III-D-1. Contd.

IRIG	Time	Delta t	Camera	Event
				More than half roof fragmented
				Large frags flying out
				SE wall joint relatively undamaged
	3.023700	0.938125	SE	The large frag with 2 black stripes seen in NE disc seen here
				This frag is about 2 feet long
				Upper part of SE joint breaking out
				Lots of large frags in the air
	3.039638	0.954063	NW	Big white fragment with 2 black stripes
	3.070107	0.984532	SW	Continuation of roof pivot
				Fireball
				expanding debris cloud
	3.102450	1.016875	NE	Door completely on ground having pivoted about lower edge
				Big fireball above roof
				Very large frags
				Lid of drum lands near door
	3.124012	1.038437	NW	Door frame down
				Structure fragmenting
				Fragments from roof and north face
				fragment with 2 black stripes still rotating
	3.126825	1.041250	SE	Large frag with 2 black stripes still traveling out
				Roof now at about 180 degrees
				S and E walls still relatively intact
	3.156514	1.070939	SE	lots of large frags in air

TABLE III-D-1. Contd.

IRIG	Time	Delta t	Camera	Event
				still a large fireball but diminished
	3.221669	1.136094	SW	Still intense fireball
				Movement of what left of Kasun
				W and S walls still intact
				Big frags
	3.318075	1.232500	NE	large 2 black stripe frag rotating just about out of picture
				still intense fire ball and big frags in air
	3.238857	1.153282	SW	Still intense fireball in northern part of Kasun
				Structure rocked back
	3.391981	1.306406	SW	What's left of roof hits S wall
	3.472139	1.386564	SE	what left of roof impacts S wall
				Still big fireball
	3.472762	1.387187	NE	Still large fireball and big frags
	3.590420	1.504845	SE	E, S, and W walls still standing

Still big fireball and still lots of big frags in air.

Appendix III-E

HD1.3 TEST 2 IR DATA

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FIGURE III-E-1. Black and White IR Image #1, Camera 1.

FIGURE III-E-2. Black and White IR Image #2, Camera 1.

FIGURE III-E-3. Black and White IR Image #3, Camera 1.

FIGURE III-E-4. Black and White IR Image #4, Camera 1.

FIGURE III-E-5. Black and White IR Image #5, Camera 1.

FIGURE III-E-6. Black and White IR Image #6, Camera 1.

FIGURE III-E-7. Black and White IR Image #1, Camera 2.

FIGURE III-E-8. Black and White IR Image #2, Camera 2.

FIGURE III-E-9. Black and White IR Image #3, Camera 2.

FIGURE III-E-10. Black and White IR Image #4, Camera 2.

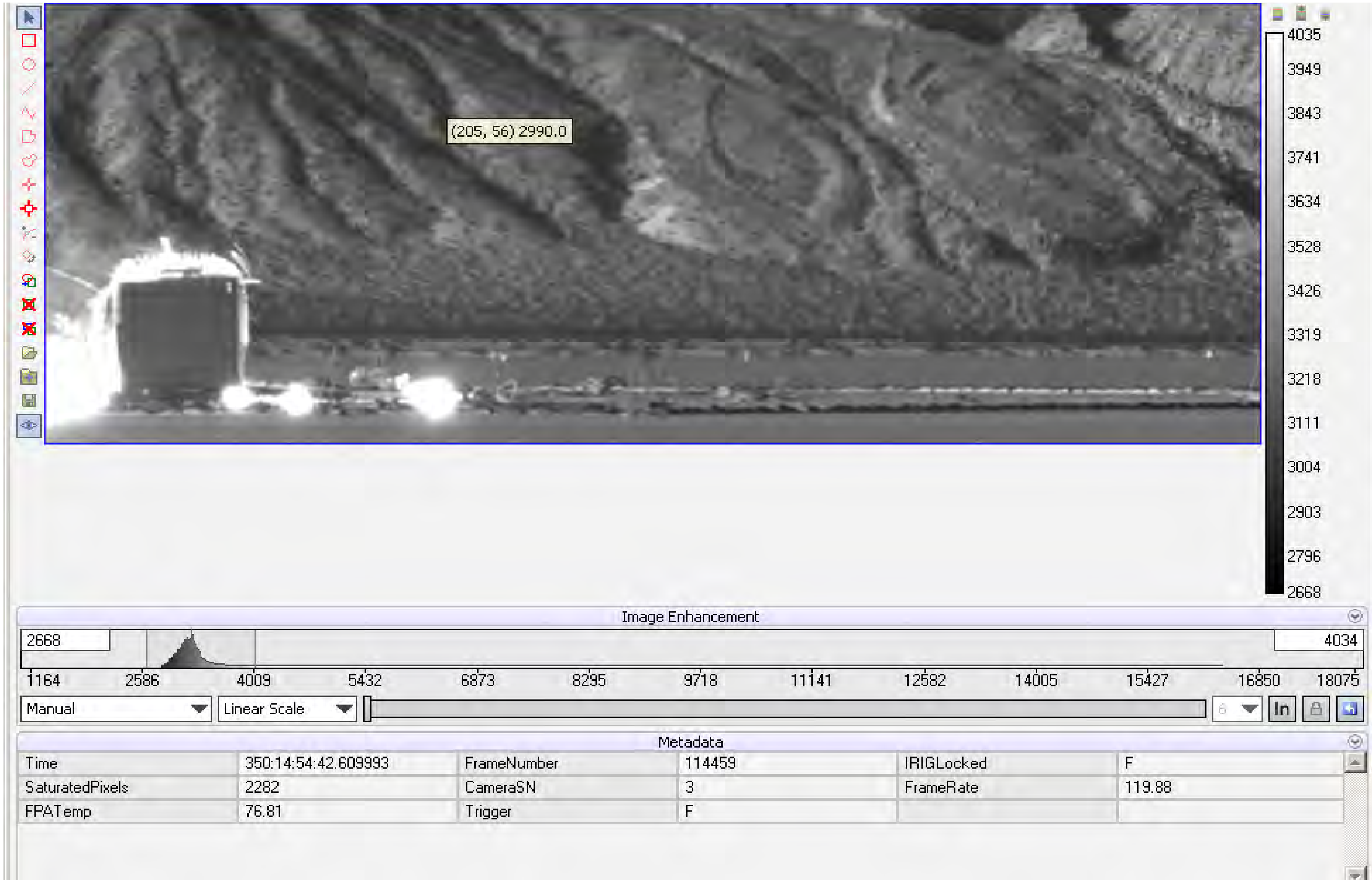

FIGURE III-E-11. Black and White IR With Thermal Scale.

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Appendix III-F

HD1.3 TEST 2 DOPPLER DATA

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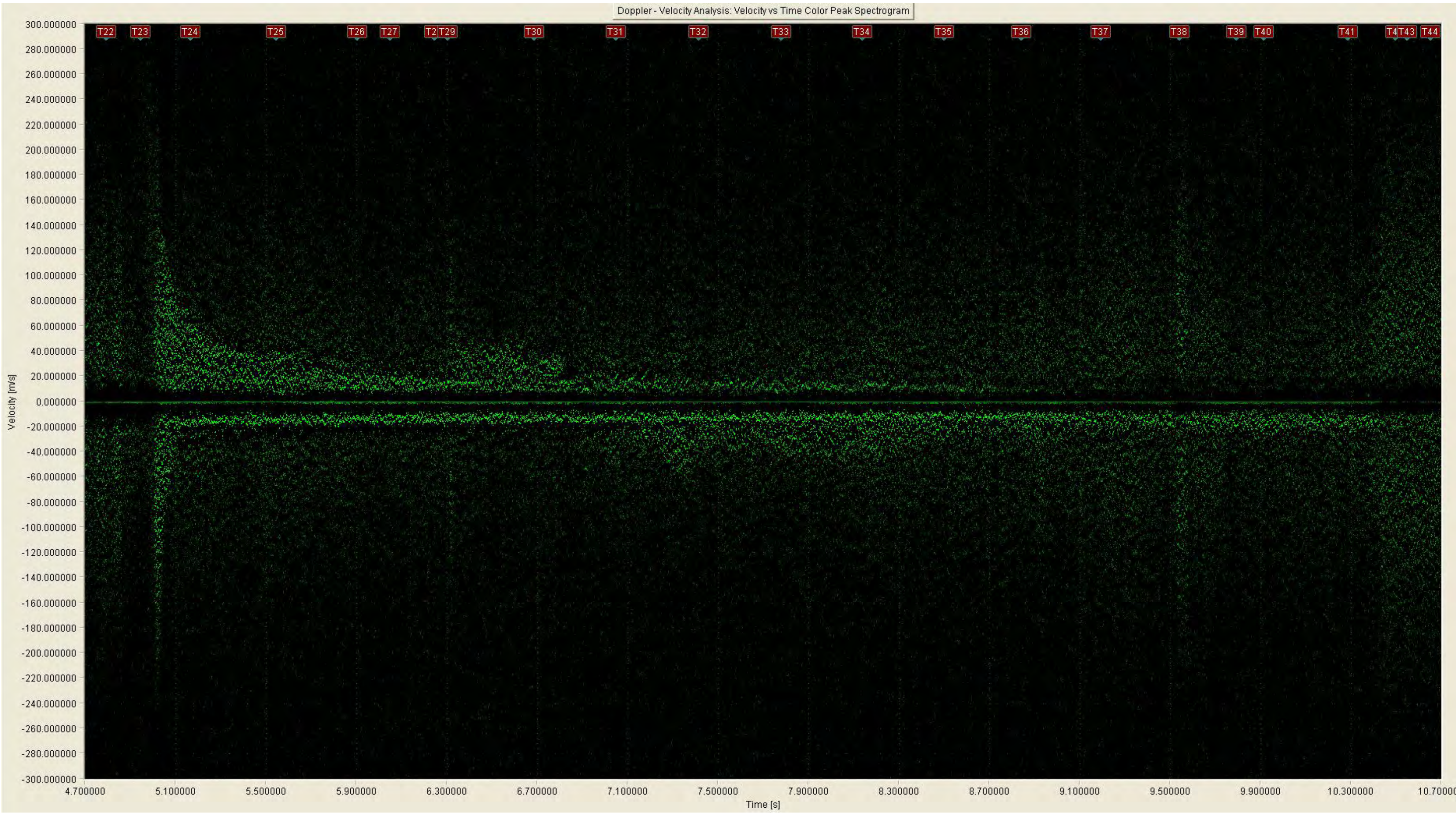

FIGURE III-F-1. Bunker 2K FFT DTI-0 Plot.

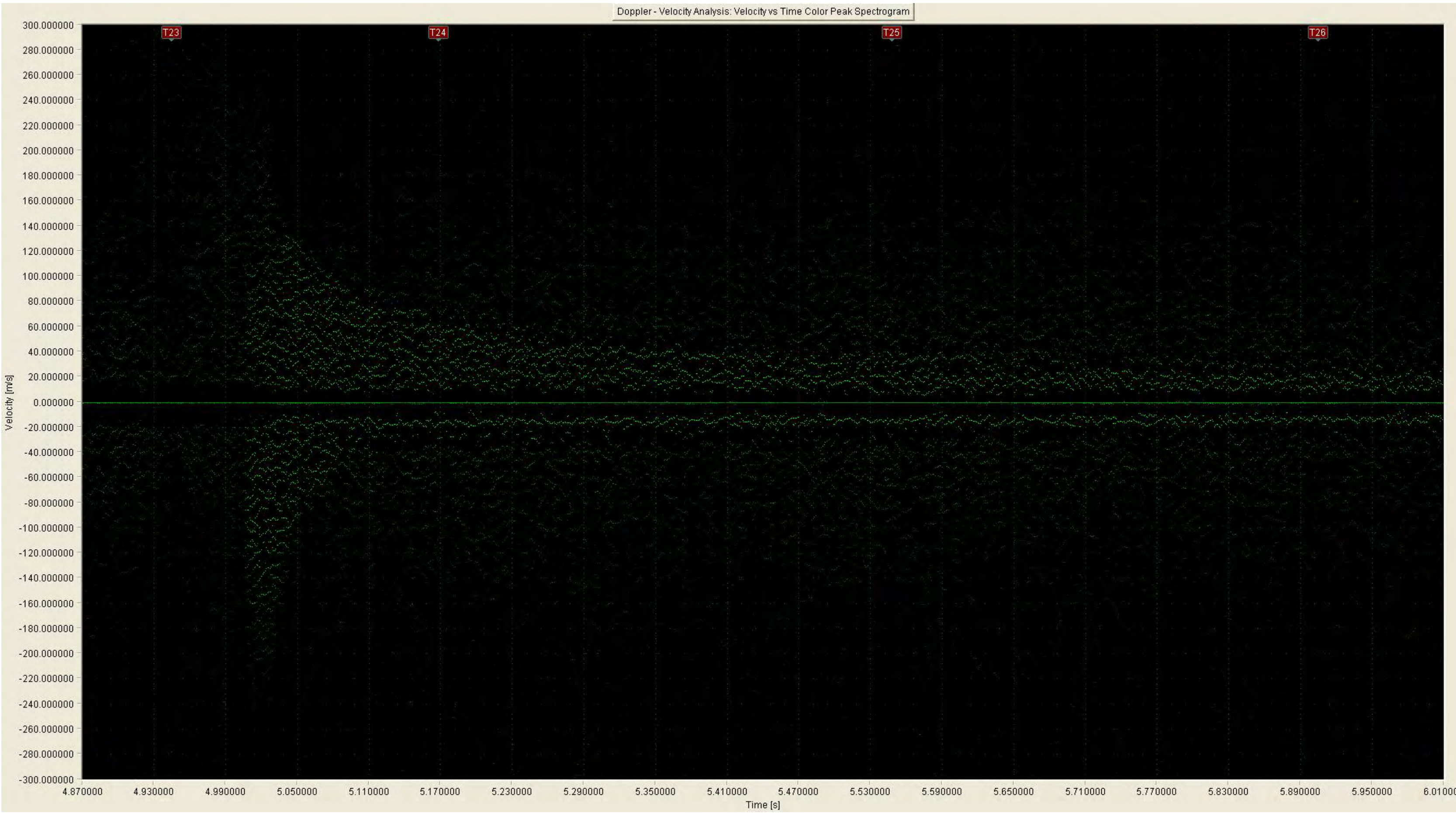

FIGURE III-F-2. Bunker 1K FFT DTI-1 Plot.

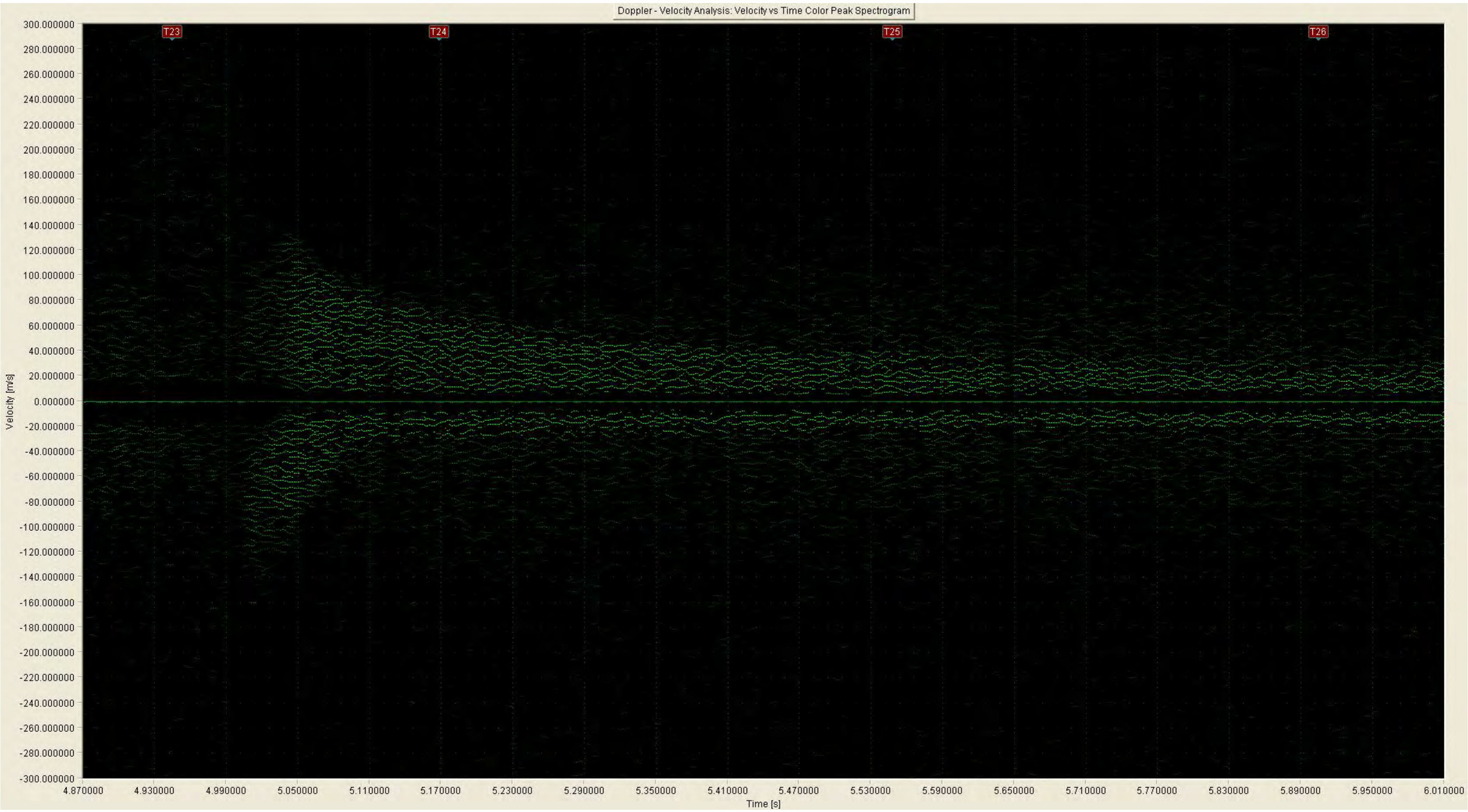

FIGURE III-F-3. Bunker 2K FFT DTI.

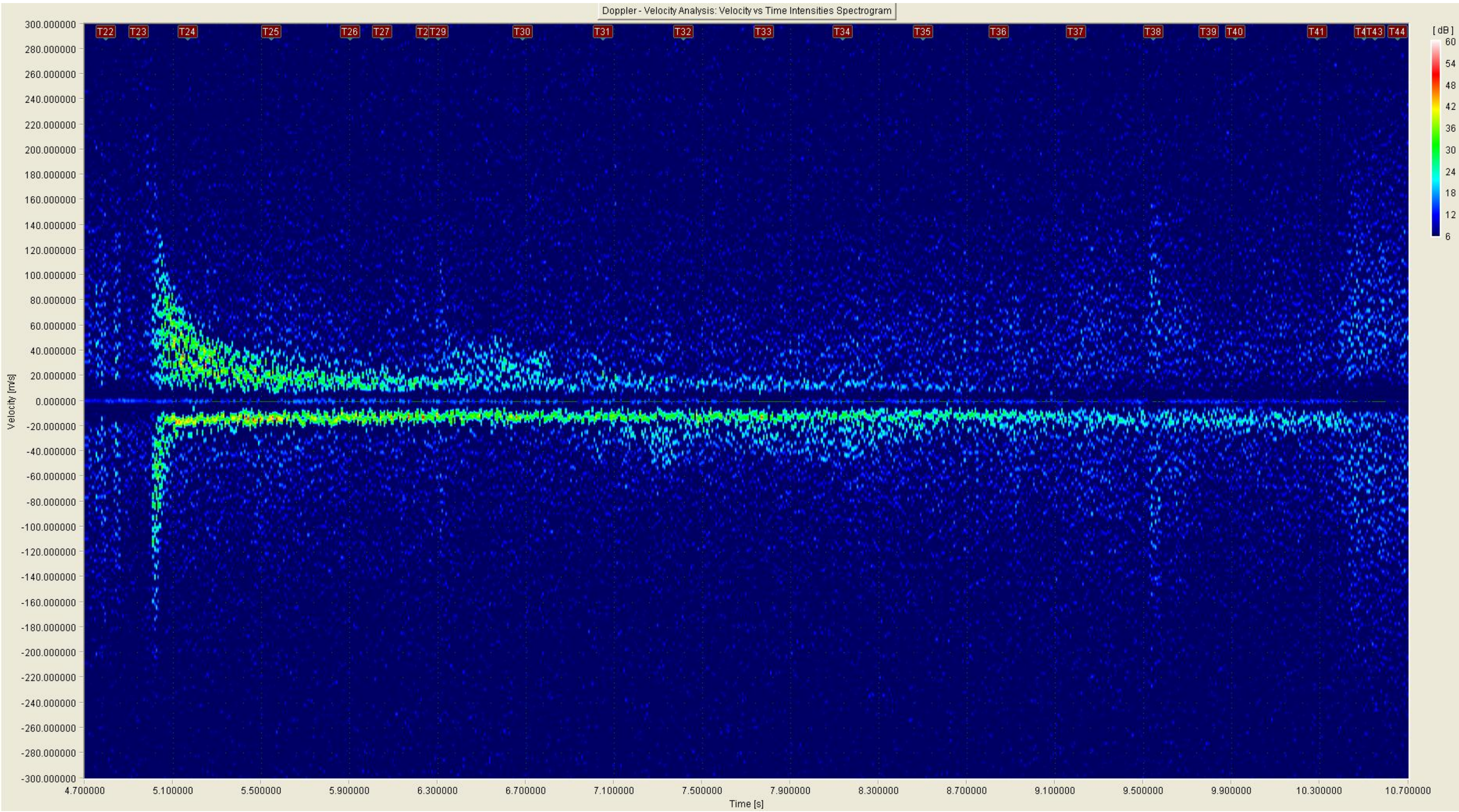

FIGURE III-F-4. Bunker 1K FFT Intensity-0.

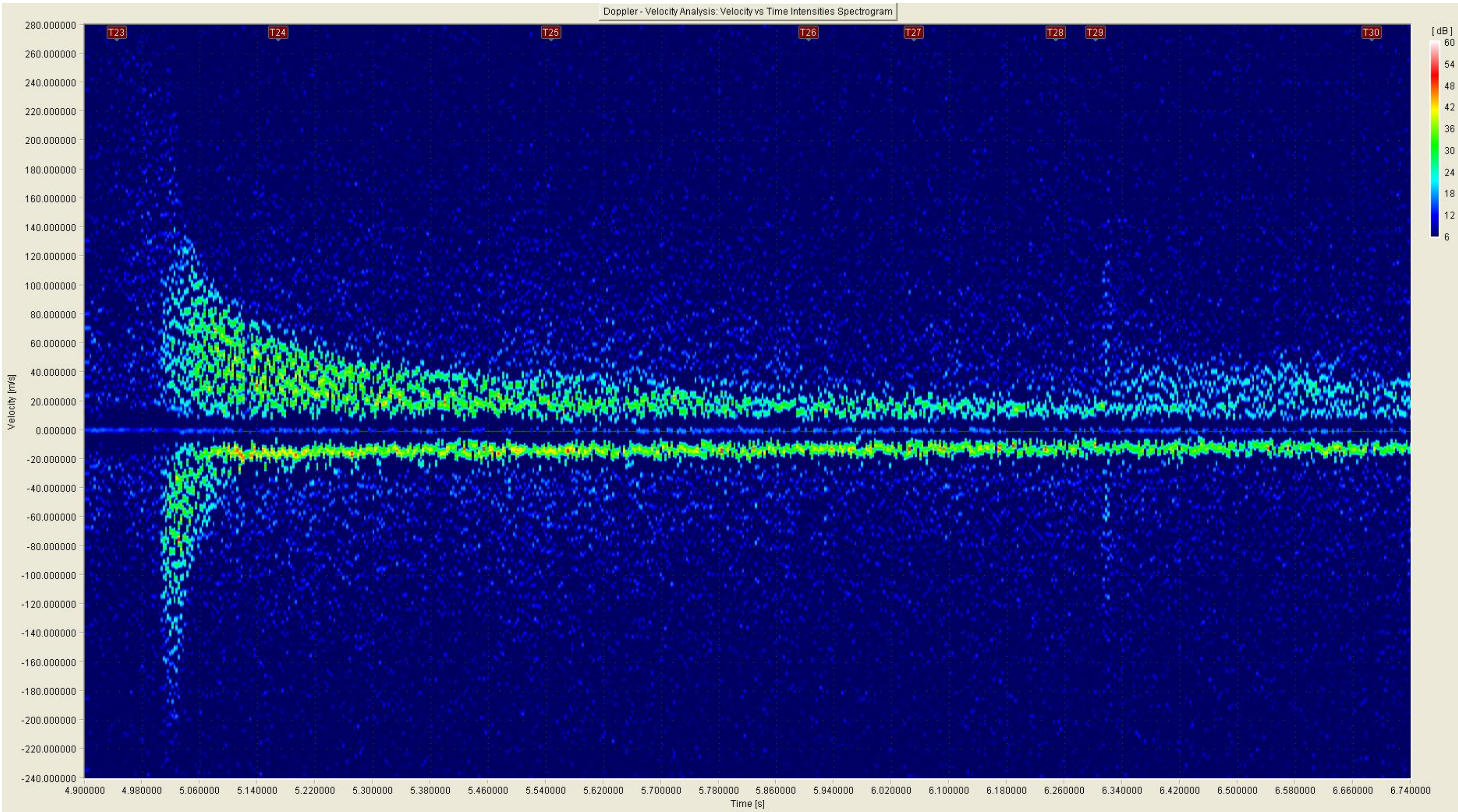

FIGURE III-F-5. Bunker 1K FFT Intensity.

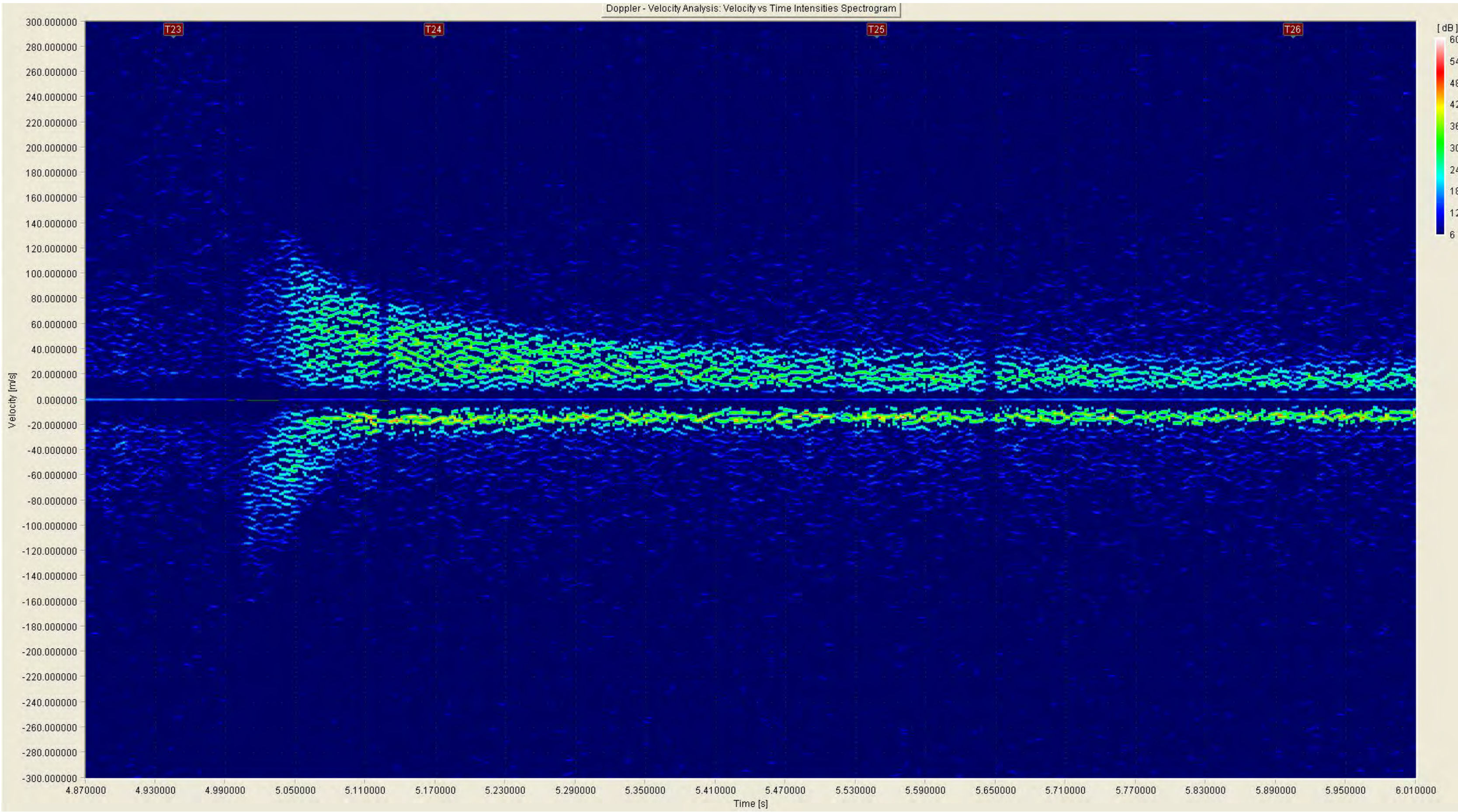

FIGURE III-F-6. Bunker 2K FFT Intensity.

Summary

- No Fragments Detected

- Initial Velocity of Plume 19 m/s

- Peak Velocity of Plume
  - 138 m/s away from structure
  - 208 m/s toward structure

- Duration of Plume 5.4 seconds

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Appendix III-G

HD1.3 TEST 2. FRAGMENT DATA TABLE AND FRAGMENT MAPS

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This appendix is in two parts: (1) the Fragment Data Table, and (2) Fragment Maps for each of the weight groups, with photographs of some of the most significant structural debris.

FRAGMENT DATA TABLE

The fragment data table is presented in Table III-G-1. The 2500+ entries give the fragment identification number, the color of the fragment indicating where the fragment originated (black for roof, grey for north wall, yellow for east wall, red for rear wall, and green for west wall), the mass of the fragment in grams, notes such as photograph number if a photograph was taken, the GPS coordinates in meters, and the distance from the door of the structure in meters.

TABLE III-G-1. Fragment Data Table.

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
4064	Black	8400.00	p144 999-1	431100.9571	3974328.2874	37.84
155	Black	7260.00	p111	431088.3250	3974290.1667	8.91
496	Black	7082.00	p112	431124.3411	3974361.6392	78.53
161	Black	7055.00	p115	431090.7111	3974288.3446	11.91
76	Grey	6665.00	p107	431076.8792	3974301.9949	7.66
160	Black	5815.00	p114	431090.0933	3974289.1977	10.90
638	Black	5725.00	p141	431113.6041	3974333.4245	49.44
4065	Black	5594.00	p145-146	431100.0485	3974333.7564	42.22
162	Black	5130.00	p116-117	431091.6662	3974288.3686	12.66
4063	Black	4958.00	p143	431103.4473	3974331.0567	41.51
631	Black	4805.00	corner, p137	431131.8582	3974328.2530	59.91
697	Black	4499.20	p145	431102.4053	3974361.8743	69.26
261	Black	4405.00	p129	431094.7610	3974284.8726	17.25
1290	Black	4275.00	p136	431099.7898	3974311.0961	23.84
1683	Other	4020.00	rebar	431065.4281	3974261.2490	38.14
637	Black	3855.60	p139	431113.2717	3974331.6830	47.91
180	Black	3485.00	p122-123	431088.7934	3974305.8949	12.43
167	Black	3175.00	p118	431093.7962	3974289.9553	13.67
168	Black	3125.00	p119	431093.4102	3974289.7974	13.40
577	Black	3024.10	p126	431054.7590	3974243.0035	59.21
156	Black	2925.00	p112-113	431088.7914	3974289.8324	9.49
285	Black	2910.00		431087.8029	3974312.0284	17.37
200	Grey	2865.00	p128	431071.4966	3974304.9878	13.52

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
269	Black	2835.00	p130	431100.4232	3974290.8389	19.61
187	Grey	2790.00	p124	431084.6183	3974308.5149	13.05
194	Black	2705.00	p127	431074.6070	3974304.6989	11.19
304	Black	2635.00	p133	431069.0077	3974303.3642	14.54
63	Grey	2605.00	p103	431084.2999	3974304.1530	8.77
1293	Black	2568.00	p137-138	431096.2009	3974315.0551	24.21
300	Black	2480.00	p131-132	431068.3314	3974307.0325	17.24
3936	Black	2478.00	p142	431072.8885	3974264.3731	32.63
33	Grey	2475.00	p94	431088.8569	3974293.0019	7.93
1294	Black	2404.00	p139	431094.6400	3974315.1496	23.37
1288	Black	2378.00	p135	431102.4898	3974307.5689	24.07
615	Black	2371.70	p134	431066.5743	3974246.6118	51.44
169	Black	2305.00	p120	431094.9489	3974289.1615	15.06
175	Black	2275.00	p121	1.0000	3974299.5370	431080.46
40	Black	2250.00	black and grey p98	431090.4826	3974295.5088	9.03
107	Black	2185.00	p110	431077.1926	3974291.7638	5.91
1305	Black	2134.00	p141	431064.6802	3974307.8093	20.60
188	Other	2030.00	rebar	431084.3954	3974309.3999	13.86
1682	Other	2028.00	rebar	431062.3592	3974268.1740	33.63
296	Black	2025.00		431074.8065	3974309.4044	15.10
1684	Other	2018.00	rebar	431076.8198	3974270.2306	26.04
1681	Black	2012.00		431060.3568	3974267.5512	35.30
1680	Other	1982.00	rebar	431057.7868	3974268.2997	36.33
89	Other	1970.00	rebar	431076.7514	3974297.8389	5.11
90	Other	1965.00	rebar	431076.6902	3974291.3800	6.54
538	Black	1956.20	p115	431040.2804	3974247.6427	63.40
4370	Black	1952.00		431060.6918	3974281.8380	25.06
272	Grey	1940.00	black and grey	431103.0924	3974296.6801	21.65
344	Other	1925.00	rebar	431076.9841	3974280.5376	15.96
189	Other	1920.00	rebar	431081.3277	3974307.3419	11.49
1464	Other	1862.00	rebar	431052.9096	3974255.3860	49.53
582	Black	1860.40	p129	431051.4396	3974245.9586	58.23
368	Black	1855.00		431084.6389	3974278.9813	17.17
1679	Other	1853.00	rebar	431052.2085	3974265.1791	42.39
364	Black	1835.00		431081.6123	3974278.8690	16.98
385	Black	1828.40	p640	431066.7256	3974322.5383	30.48
1463	Other	1825.00	rebar	431053.1636	3974257.6260	47.56
1281	Black	1823.00	p134	431105.7679	3974289.4110	25.15
598	Black	1822.60	p131	431059.2245	3974250.9123	50.14

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
3888	Black	1767.00		431064.7636	3974267.8600	32.59
66	Other	1765.00	rebar	431085.4733	3974303.7498	8.86
163	Black	1760.00		431091.6646	3974289.6035	11.96
298	Black	1710.00		431068.9874	3974309.4847	18.48
611	Black	1701.10	p132	431063.2773	3974249.7970	49.52
4253	Black	1672.00	p147	431063.2652	3974310.3305	23.25
492	Black	1671.00	p111	431041.0550	3974233.0773	74.66
52	Grey	1665.00	p100-101	431090.4173	3974296.1889	8.96
1282	Black	1624.00		431104.6218	3974296.0686	23.16
578	Black	1607.90	p127	431053.2213	3974243.7359	59.28
51	Grey	1565.00	p99	431093.6081	3974299.3048	12.63
553	Black	1562.10	p118	431049.2738	3974251.9575	54.43
1406	Black	1559.00		431046.5361	3974261.7552	48.81
278	Black	1520.00		431091.7829	3974313.4469	20.40
2260	Black	1513.00		431068.8688	3974255.0343	42.72
1306	Black	1503.00		431063.7040	3974305.0341	19.99
625	Black	1499.80	p136	431059.9457	3974241.0153	58.91
73	Grey	1485.00	p105	431081.5548	3974304.2411	8.39
4152	Black	1470.00		431091.8140	3974332.5215	38.10
308	Black	1465.00		431065.8833	3974294.1203	15.67
564	Black	1462.80	p122	431047.6509	3974248.7547	57.98
523	Black	1449.30	p113	431038.2357	3974260.9518	55.56
573	Black	1438.50	p123	431051.3250	3974233.9305	68.87
630	Black	1422.90		431110.8799	3974271.9966	37.88
384	Black	1385.20	p639	431066.5264	3974322.3898	30.45
4297	Black	1366.00		431056.0266	3974294.8889	25.45
263	Black	1365.00		431094.0950	3974286.7558	15.57
3926	Black	1361.00		431070.1684	3974259.2412	38.31
206	Black	1355.00		431070.1863	3974300.1345	12.06
1307	Black	1339.00		431062.3325	3974304.5627	21.02
4371	Black	1329.00		431060.4088	3974280.6476	25.97
87	Black	1295.00	p108	431076.6650	3974296.9857	4.93
4095	Black	1292.00		431094.3951	3974323.5919	30.61
613	Black	1291.40		431064.7416	3974247.2562	51.39
1480	Black	1289.00		431054.2598	3974254.7826	49.26
3983	Black	1288.00		431108.0057	3974306.7151	28.68
273	Black	1285.00		431099.4694	3974298.8336	18.25
4332	Black	1275.00		431052.8335	3974282.4512	31.61
585	Black	1272.50		431054.0924	3974248.5355	54.66

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
1295	Black	1271.00	p140	431094.2262	3974315.7790	23.66
179	Black	1265.00		431090.2825	3974304.8365	12.59
176	Grey	1260.00		431096.5387	3974299.7104	15.56
1934	Black	1253.00		431062.5007	3974277.7872	26.19
580	Black	1250.80	p128	431053.1598	3974244.2501	58.85
56	Grey	1250.00	p102	431088.6727	3974299.6925	8.17
2218	Black	1247.00		431060.1994	3974260.2850	41.44
96	Black	1245.00	p109	431075.2346	3974291.9891	7.33
299	Black	1245.00		431067.6835	3974306.9810	17.71
342	Other	1245.00	rebar	431073.4881	3974278.5782	19.03
1471	Black	1245.00		431051.6689	3974256.2888	49.53
34	Grey	1235.00	p95	431088.6652	3974293.3017	7.64
157	Black	1230.00		431089.0328	3974289.8855	9.64
4254	Black	1204.00	p149	431054.0903	3974308.8907	30.32
3910	Black	1203.00		431066.2177	3974264.7346	34.65
3927	Black	1203.00		431069.1131	3974259.5746	38.32
134	Black	1195.00		431080.0848	3974288.1955	7.78
2259	Black	1169.00		431067.6629	3974258.7925	39.55
354	Black	1160.00		431073.7797	3974278.1826	19.27
2115	Black	1159.00		431062.2278	3974268.6986	33.28
131	Black	1130.00		431080.0957	3974289.4996	6.50
226	Black	1130.00		431074.5058	3974286.0075	12.05
140	Black	1125.00		431081.8392	3974287.0876	8.77
1300	Black	1125.00		431081.2385	3974322.2325	26.38
164	Black	1120.00		431091.2536	3974288.6899	12.13
629	Black	1112.30		431080.0458	3974256.9770	38.90
4019	Black	1106.00		431107.8984	3974323.6455	38.36
297	Black	1105.00		431070.5312	3974309.2429	17.28
212	Black	1090.00		431070.1625	3974292.7645	11.71
69	Black	1085.00		431082.9579	3974303.5366	7.83
555	Black	1085.00	p119	431050.3970	3974251.6278	54.04
190	Other	1075.00	bucket lid p125-126	431082.4810	3974310.2390	14.42
2017	Black	1068.00		431063.5013	3974272.1198	29.76
3987	Black	1067.00		431103.8566	3974311.0545	27.07
3992	Black	1067.00		431106.5232	3974314.2281	31.08
80	Black	1055.00		431076.4518	3974300.2656	6.68
1276	Black	1053.00		431081.1784	3974271.8976	23.96
325	Black	1050.00		431071.4070	3974281.1892	17.78
74	Grey	1045.00	p106	431080.9753	3974304.3101	8.47

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
4035	Black	1042.00		431102.2882	3974322.8737	34.12
207	Black	1035.00		431070.8524	3974296.6461	10.64
290	Black	1025.00		431078.4190	3974314.7013	19.09
210	Black	1020.00		431069.4962	3974294.0865	12.09
4195	Black	1020.00		431081.8917	3974328.7846	32.93
3921	Black	1019.00		431070.5800	3974263.1743	34.44
1638	Black	1016.00		431056.1453	3974271.8777	34.87
1308	Black	992.00		431063.0651	3974305.6422	20.84
606	Black	990.20		431058.0135	3974246.1536	54.95
177	Grey	990.00		431095.6479	3974301.8683	15.41
1270	Black	989.00		431078.4564	3974272.6171	23.43
123	Black	985.00		431076.2447	3974288.6923	8.86
291	Black	985.00		431076.0343	3974312.8295	17.82
2244	Black	981.00		431064.1592	3974260.2835	39.55
1274	Black	973.00		431080.6914	3974272.9238	22.94
3954	Black	959.00		431074.3216	3974269.6521	27.16
1566	Black	952.00		431055.7878	3974274.5831	33.34
1352	Black	951.00		431047.0151	3974268.2371	44.15
75	Black	940.00		431076.5436	3974304.2922	9.77
624	Black	921.10		431066.3317	3974243.2967	54.69
143	Black	915.00		431081.5974	3974290.4321	5.42
145	Black	915.00		431082.6327	3974289.2163	6.74
209	Black	915.00		431068.8921	3974293.8056	12.73
528	Black	900.40	p114	431036.3249	3974248.2487	65.60
72	Grey	900.00	p104	431081.8817	3974302.4292	6.59
141	Black	900.00		431082.4242	3974286.6207	9.28
1473	Black	898.00		431050.2920	3974254.5116	51.77
1470	Black	897.00		431051.5853	3974256.6261	49.31
2138	Black	897.00		431062.4544	3974266.4426	35.02
393	Black	890.60		431066.4835	3974330.7497	37.98
4080	Black	888.00		431099.5573	3974329.0190	37.78
310	Black	885.00		431067.4769	3974291.1543	14.75
97	Black	880.00		431074.7335	3974291.6348	7.94
3993	Grey	876.00		431102.9288	3974314.3956	28.37
139	Black	875.00		431081.8580	3974287.2454	8.62
208	Black	875.00		431071.0574	3974296.5441	10.43
605	Black	874.70		431056.6403	3974245.3528	56.27
602	Black	871.60		431060.4975	3974249.9949	50.42
1806	Black	849.00		431053.8103	3974259.9511	45.32

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
103	Black	845.00		431075.8375	3974291.8198	6.92
1445	Black	845.00		431051.3601	3974259.5225	47.18
1343	Black	834.00		431046.2062	3974269.2306	44.18
2004	Black	833.00		431062.1680	3974273.1723	29.78
1725	Black	832.00		431052.1522	3974262.7735	44.20
275	Black	830.00		431097.1776	3974311.4816	22.16
106	Black	825.00		431076.0596	3974289.9287	8.02
632	Black	815.90		431123.6471	3974331.1898	55.03
117	Black	815.00		431078.0479	3974290.8882	6.02
144	Black	815.00		431082.8891	3974289.0199	6.98
621	Black	812.70		431068.8877	3974246.1583	51.26
579	Black	809.10		431053.0661	3974243.9093	59.20
1483	Black	804.00		431055.5009	3974254.4614	48.86
137	Black	800.00		431081.9614	3974288.2842	7.59
1272	Black	799.00		431078.0737	3974271.7658	24.32
39	Grey	795.00		431089.8951	3974295.2651	8.45
617	Black	788.20		431064.9675	3974251.4662	47.35
1847	Black	788.00		431056.8848	3974260.9768	42.67
692	Black	779.10		431104.0421	3974365.1606	72.89
277	Black	775.00		431092.4528	3974309.7732	17.74
357	Black	775.00		431078.0762	3974278.9491	17.24
314	Black	774.00		431068.0543	3974285.5101	16.93
174	Grey	765.00		431094.7769	3974294.8205	13.36
1284	Black	765.00		431106.0069	3974302.6818	25.48
4347	Black	762.00		431062.8112	3974282.5238	22.92
172	Black	760.00		431094.8972	3974291.0238	14.28
1268	Black	758.00		431075.8296	3974272.1328	24.38
2221	Black	756.00		431061.0889	3974261.4540	39.98
205	Black	755.00		431072.9772	3974301.4997	10.19
557	Black	753.70	p120	431051.4994	3974251.8594	53.23
1866	Black	753.00		431058.6482	3974259.9102	42.57
570	Black	740.30		431046.0315	3974242.3682	64.16
359	Black	740.00		431079.3157	3974278.5603	17.43
1314	Black	739.00		431062.0123	3974291.9686	19.83
693	Black	737.30		431102.6919	3974363.8446	71.23
373	Black	730.00		431068.6656	3974277.1869	22.63
150	Black	725.00		431084.2378	3974288.2272	8.12
609	Black	722.60		431061.9790	3974250.1177	49.71
3969	Black	717.00		431081.8649	3974269.6902	26.17

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
3972	Black	711.00		431098.1665	3974272.6971	28.55
191	Grey	710.00		431078.1259	3974306.2487	10.92
614	Black	709.40		431064.9746	3974246.0291	52.48
1258	Black	709.00		431069.9477	3974274.4275	24.32
719	Black	708.30		431100.2428	3974336.0106	44.33
237	Black	705.00		431077.7973	3974286.4299	10.11
371	Black	705.00		431067.3656	3974280.8096	20.62
571	Black	703.50		431048.6453	3974240.8851	64.02
148	Black	700.00		431083.4413	3974285.6160	10.43
293	Black	700.00		431081.2125	3974312.1706	16.32
1310	Black	700.00		431062.0891	3974297.8426	19.47
1880	Black	699.00		431056.6564	3974257.1440	45.97
204	Black	695.00		431072.0819	3974301.1411	10.77
2090	Black	695.00		431058.2201	3974267.2327	36.87
4162	Black	691.00		431086.6245	3974326.9300	31.50
38	Black	690.00		431089.4384	3974294.8709	8.04
1851	Black	689.00		431057.3138	3974261.9078	41.66
551	Black	686.10	p117	431047.3608	3974251.3046	56.10
1876	Black	680.00		431055.3176	3974258.4050	45.67
728	Black	677.20		431092.9413	3974339.0664	44.71
258	Black	670.00		431082.3385	3974281.9488	13.93
108	Black	655.00		431077.1120	3974291.5244	6.14
170	Black	655.00		431094.2168	3974288.9618	14.50
1359	Black	650.00		431049.9772	3974268.4834	41.72
1914	Black	648.00		431059.4100	3974279.8253	27.26
147	Black	640.00		431082.4611	3974287.1701	8.74
110	Black	635.00		431078.5801	3974292.6418	4.31
340	Black	635.00		431072.8192	3974278.8136	19.11
3850	Black	633.00		431070.1998	3974271.0366	27.25
370	Black	630.00		431069.5504	3974281.0048	19.04
104	Black	625.00		431075.8684	3974291.0554	7.37
274	Black	625.00		431099.7743	3974301.8883	19.28
365	Black	625.00		431081.5041	3974279.0505	16.80
562	Black	620.90		431048.8819	3974247.9047	57.97
109	Black	615.00		431078.0200	3974292.1488	5.06
2254	Black	609.00		431064.9680	3974253.6532	45.31
198	Black	606.00		431072.2367	3974304.6588	12.75
1297	Black	606.00		431085.5562	3974322.1352	26.60
1908	Black	606.00		431058.5190	3974254.4339	47.35

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
202	Black	605.00		431071.8821	3974301.9501	11.36
569	Black	603.50		431047.4279	3974246.8096	59.70
572	Black	595.10		431049.2394	3974241.8279	62.90
60	Black	595.00		431087.4633	3974304.0166	10.13
271	Black	595.00		431093.1102	3974280.5674	19.22
565	Black	588.70		431047.5672	3974248.9034	57.91
1241	Black	587.00		431067.4917	3974282.8359	19.09
142	Other	580.00	rebar	431081.8329	3974286.3725	9.49
1620	Black	576.00		431050.9372	3974269.8314	40.11
35	Yellow	575.00	and grey p96	431088.8953	3974293.7522	7.73
136	Black	570.00		431080.7810	3974287.5040	8.38
303	Black	565.00		431069.9370	3974303.4326	13.79
216	Black	560.00		431073.9229	3974289.2208	10.04
279	Black	560.00		431092.0369	3974313.4027	20.49
281	Other	560.00	dft 5	431091.9279	3974312.6562	19.80
322	Black	560.00		431072.4517	3974284.7137	14.33
444	Black	558.20		431073.0203	3974315.3593	21.25
99	Black	555.00		431077.1000	3974294.1125	4.70
280	Black	555.00		431091.5582	3974313.0740	19.96
561	Black	553.90		431050.0783	3974247.5702	57.59
135	Black	545.00		431079.2518	3974287.6195	8.52
158	Black	545.00		431088.5698	3974288.1049	10.51
1778	Black	545.00		431053.5200	3974261.4794	44.30
1705	Black	543.00		431054.3302	3974266.2266	40.17
1234	Black	539.00		431065.3955	3974286.7527	18.46
1667	Black	538.00		431052.6916	3974268.2692	39.86
1687	Black	538.00		431055.9971	3974268.2265	37.57
67	Grey	535.00		431084.5764	3974302.2179	7.09
548	Black	534.40	p116	431047.4443	3974252.7117	54.94
1932	Black	533.00		431063.0979	3974278.4633	25.29
3922	Black	533.00		431071.5815	3974264.2382	33.12
3974	Black	533.00		431101.8317	3974276.4152	28.16
1330	Black	527.00		431047.0619	3974274.5020	40.49
1657	Black	522.00		431054.9870	3974269.3085	37.49
545	Black	520.70		431042.0527	3974245.3643	64.05
61	Black	520.00		431088.9470	3974304.9844	11.81
1870	Black	519.00		431057.2155	3974259.8586	43.40
567	Black	517.60		431045.6429	3974246.2261	61.20
68	Black	515.00		431083.3666	3974303.5045	7.89

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
138	Black	515.00		431081.8706	3974288.4542	7.41
183	Black	515.00		431086.9716	3974307.4221	12.81
1329	Black	515.00		431050.1709	3974274.9047	37.66
452	Black	511.70		431070.9809	3974312.7722	19.90
1311	Black	509.00		431061.8054	3974298.0549	19.78
378	Black	505.00		0.0000	0.0000	3997606.63
626	Black	504.20		431058.7770	3974241.7153	58.70
101	Black	500.00		431077.2105	3974292.5541	5.38
612	Black	490.10		431065.7803	3974248.1432	50.22
1596	Black	487.00		431058.2714	3974274.0697	31.82
1244	Black	484.00		431067.1458	3974282.1967	19.78
4322	Black	483.00		431059.1563	3974284.8131	24.89
470	Black	481.90		431073.2224	3974312.9353	18.97
46	Grey	480.00		431091.7865	3974294.8189	10.38
130	Black	480.00		431079.8940	3974289.8059	6.25
361	Black	480.00		431079.1354	3974277.3787	18.62
1401	Black	480.00		431051.1321	3974264.0554	43.94
195	Black	475.00		431074.3472	3974303.7110	10.60
331	Black	475.00		431072.4018	3974281.9070	16.63
1273	Black	473.00		431080.1250	3974272.5307	23.36
490	Black	472.10	p109	430984.4951	3974322.1773	100.48
36	Black	470.00	black and grey p97	431089.0534	3974294.1250	7.79
559	Black	467.60		431050.6787	3974248.7809	56.24
49	Black	465.00		431093.2110	3974297.9293	11.93
196	Black	465.00		431075.1421	3974302.9275	9.49
234	Black	465.00		431075.4005	3974284.9056	12.51
301	Black	465.00		431069.2680	3974304.8406	15.15
2261	Black	465.00		431069.9790	3974254.6239	42.80
2168	Black	461.00		431059.4085	3974266.0284	37.09
151	Black	460.00		431085.7852	3974289.5047	7.68
525	Black	454.20		431036.6677	3974254.4392	61.00
463	Black	453.00		431072.2775	3974312.8969	19.36
126	Black	445.00		431077.3790	3974287.6464	9.17
259	Black	445.00		431083.8035	3974282.9290	13.13
546	Black	444.60		431040.5077	3974243.4242	66.53
1490	Black	444.00		431056.5290	3974252.6136	49.91
1887	Black	438.00		431057.8195	3974258.3310	44.35
3731	Black	436.00		431064.7614	3974275.1381	26.61
253	Black	435.00		431080.5245	3974280.7730	15.11

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
1886	Black	435.00		431057.6615	3974256.9635	45.59
603	Black	432.90		431058.5040	3974248.6224	52.51
256	Black	430.00		431082.9582	3974283.3340	12.61
1280	Black	430.00		431097.5869	3974278.3798	23.78
1255	Black	428.00		431069.5215	3974277.3448	22.03
1912	Black	427.00		431063.4508	3974252.9449	46.53
2184	Black	426.00		431058.9852	3974264.7872	38.34
77	Black	425.00		431077.1592	3974301.8162	7.35
289	Black	420.00		431082.2140	3974314.1447	18.31
441	Black	419.30		431072.8200	3974317.7322	23.52
124	Black	415.00		431076.7461	3974288.0917	9.08
221	Black	415.00		431074.0282	3974285.0706	13.10
363	Black	415.00		431081.3399	3974277.6807	18.17
1286	Black	414.00		431103.2488	3974307.1135	24.53
2075	Black	411.00		431061.2836	3974269.0234	33.57
2156	Black	411.00		431060.2056	3974266.1217	36.55
336	Black	410.00		431073.6859	3974281.9375	15.94
2262	Black	409.00		431068.5152	3974253.7675	44.03
1439	Black	407.00		431050.0181	3974258.5830	48.76
295	Black	405.00		431074.1422	3974308.8351	14.90
608	Black	404.20		431059.2344	3974246.2177	54.38
1481	Black	402.00		431055.0294	3974255.4249	48.30
574	Black	398.10		431052.0413	3974233.3635	69.07
1264	Black	398.00		431076.6879	3974275.6594	20.75
288	Black	395.00		431083.1257	3974315.7865	20.00
1648	Black	395.00		431056.9556	3974270.5327	35.24
1402	Black	393.00		431051.4071	3974264.6008	43.36
1374	Black	392.00		431048.2868	3974264.7536	45.47
851	Black	389.00		431035.1663	3974282.7367	48.12
154	Black	385.00		431088.0277	3974290.3652	8.56
233	Black	385.00		431075.4901	3974284.8231	12.54
320	Black	385.00		431071.7016	3974285.5405	14.20
1468	Black	385.00		431052.3517	3974256.7855	48.72
1326	Black	383.00		431045.0768	3974276.6293	41.15
133	Black	380.00		431079.6733	3974288.4431	7.62
2182	Black	379.00		431058.2095	3974264.3648	39.14
100	Black	375.00		431077.9530	3974293.6511	4.14
326	Black	375.00		431071.4742	3974280.9899	17.91
435	Black	373.70		431069.5315	3974319.8432	26.79

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
3843	Black	372.00		431067.8745	3974270.2313	29.00
3959	Black	372.00		431076.1417	3974269.3492	27.03
1292	Black	369.00		431096.6209	3974313.6094	23.35
2178	Black	369.00		431059.9922	3974264.5334	37.97
121	Black	365.00		431077.6898	3974290.0396	6.93
379	Black	365.00		431070.4782	3974278.5478	20.50
1257	Black	365.00		431069.5354	3974274.9251	24.09
1408	Black	365.00		431044.4554	3974259.5665	51.83
1879	Black	365.00		431056.2027	3974257.2344	46.15
1250	Black	364.00		431065.9241	3974279.3429	22.67
848	Black	362.30		431020.0355	3974297.2820	61.44
586	Black	361.50		431053.2224	3974249.3002	54.45
1240	Black	361.00		431064.3796	3974283.9518	20.82
675	Black	360.70		431098.6753	3974335.7585	43.46
491	Black	360.30	p110	431036.7806	3974228.2663	81.02
252	Black	360.00		431078.7815	3974283.6069	12.54
321	Black	360.00		431070.7337	3974287.0935	13.85
330	Black	360.00		431072.6992	3974281.2998	16.99
3884	Black	360.00		431065.0699	3974268.6332	31.77
1385	Black	358.00		431044.6633	3974261.4538	50.37
1312	Black	356.00		431059.1048	3974297.1123	22.39
240	Black	355.00		431077.0254	3974286.2683	10.56
257	Black	355.00		431083.0954	3974283.1406	12.82
282	Black	355.00		431091.5045	3974310.0707	17.41
1235	Black	355.00		431065.1734	3974284.6493	19.77
542	Black	354.60		431043.5516	3974250.0512	59.46
1428	Black	352.00		431050.2495	3974259.7871	47.70
3964	Black	352.00		431071.2515	3974266.7248	30.87
95	Black	350.00		431073.4321	3974293.5011	8.37
309	Black	350.00		431064.0940	3974294.4167	17.43
1351	Black	348.00		431044.6809	3974266.0823	47.32
1432	Black	348.00		431049.4275	3974258.6616	49.09
2050	Black	347.00		431058.0959	3974268.8569	35.70
2242	Black	346.00		431064.7090	3974260.5839	39.05
88	Black	345.00		431076.7576	3974296.5726	4.76
302	Black	345.00		431070.2748	3974304.7615	14.30
306	Black	345.00		431068.5959	3974301.3731	14.00
1688	Black	343.00		431055.6862	3974268.3308	37.71
558	Black	342.50		431050.5566	3974249.1334	56.02

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
628	Black	342.40		431073.8534	3974253.7808	42.75
1482	Black	340.00		431055.3687	3974255.0654	48.42
1271	Black	339.00		431074.8623	3974272.6834	24.09
3889	Black	337.00		431064.5388	3974267.5113	33.01
627	Black	335.20		431062.5940	3974237.8314	61.01
211	Black	335.00		431069.5604	3974293.6213	12.11
333	Black	335.00		431073.0349	3974283.3453	15.08
338	Black	335.00		431073.3693	3974279.8297	17.95
610	Black	334.70		431062.7303	3974251.4995	48.15
604	Black	334.50		431056.7901	3974248.0587	53.79
560	Black	333.50		431049.8751	3974249.1770	56.36
1520	Black	332.00		431053.1167	3974277.2777	33.89
125	Black	330.00		431077.3887	3974287.7335	9.08
152	Black	330.00		431085.7749	3974289.7789	7.45
197	Black	330.00		431073.3814	3974303.4355	11.08
3834	Black	330.00		431065.1987	3974271.9622	28.90
1269	Black	329.00		431077.5390	3974272.8068	23.38
1469	Black	328.00		431052.2404	3974256.6592	48.89
1767	Black	328.00		431055.9008	3974264.5274	40.43
159	Black	325.00		431088.7037	3974287.1279	11.34
199	Black	325.00		431071.1009	3974303.2201	12.71
203	Black	325.00		431071.4270	3974301.7282	11.63
345	Black	325.00		431074.5383	3974282.5824	14.97
377	Black	325.00		431071.2629	3974276.8845	21.54
1407	Black	325.00		431047.4951	3974261.2526	48.49
1474	Black	321.00		431051.0049	3974254.5157	51.35
526	Black	320.90		431037.4688	3974252.6131	61.68
584	Black	319.40		431054.1385	3974247.0909	55.90
2229	Black	318.00		431062.4695	3974260.9538	39.73
193	Black	315.00		431077.3206	3974304.6284	9.70
219	Black	315.00		431070.7374	3974287.4612	13.62
225	Black	315.00		431074.4551	3974285.7470	12.30
283	Black	315.00		431089.1925	3974312.3294	18.20
1896	Black	315.00		431060.1004	3974260.4204	41.37
1842	Black	313.00		431056.1154	3974260.3686	43.61
4205	Black	312.00		431078.7089	3974327.6975	31.96
589	Black	311.60		431053.2674	3974251.6241	52.45
213	Black	310.00		431072.5429	3974288.2247	11.74
317	Black	310.00		431070.6316	3974286.0950	14.58

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
349	Black	310.00		431074.5134	3974281.0211	16.38
369	Black	310.00		431084.9510	3974279.8365	16.39
618	Black	308.90		431066.0808	3974251.0571	47.36
3929	Black	307.00		431068.9181	3974258.7637	39.15
44	Black	305.00		431092.0609	3974293.3898	10.88
111	Black	305.00		431078.5882	3974292.8126	4.18
165	Black	305.00		431090.8779	3974287.0733	12.87
305	Black	305.00		431068.7882	3974301.1748	13.75
341	Black	305.00		431073.5370	3974278.3379	19.22
1434	Black	305.00		431049.0615	3974258.4914	49.45
1256	Black	304.00		431070.3393	3974276.1044	22.67
691	Black	303.20		431103.5324	3974365.4204	72.98
3931	Black	303.00		431074.6578	3974258.0175	38.44
2179	Black	301.00		431059.9587	3974264.0951	38.35
83	Black	300.00		431074.2843	3974301.3310	9.03
166	Black	300.00		431090.5199	3974289.6894	10.96
249	Black	300.00		431079.0375	3974284.8902	11.23
311	Black	300.00		431067.0944	3974290.7781	15.24
324	Black	300.00		431071.2143	3974281.3897	17.73
623	Black	295.20		431067.6867	3974244.6187	53.05
98	Black	295.00		431074.8394	3974292.9117	7.25
286	Black	295.00		431085.4277	3974315.6575	20.20
2066	Black	294.00		431064.1483	3974270.7690	30.48
1247	Black	293.00		431066.0874	3974287.8538	17.33
4024	Black	293.00		431108.6124	3974330.2446	43.82
1586	Black	292.00		431056.1722	3974273.6605	33.65
254	Black	290.00		431080.4758	3974283.3195	12.57
1246	Black	289.00		431066.3569	3974281.9230	20.55
4318	Black	289.00		431058.1313	3974288.6212	24.43
1911	Black	284.00		431062.1724	3974255.2199	44.98
1833	Black	283.00		431057.3891	3974263.5837	40.26
1275	Black	281.00		431080.6453	3974273.6254	22.24
1898	Black	281.00		431059.5359	3974257.8628	43.86
708	Black	280.20		431097.3985	3974350.1144	56.55
307	Black	280.00		431068.5835	3974299.6178	13.42
313	Black	280.00		431067.7479	3974286.9803	16.33
1595	Black	279.00		431058.5002	3974274.5411	31.33
2129	Black	279.00		431062.8211	3974268.0001	33.51
765	Black	278.90		431080.3170	3974354.8740	59.03

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
695	Black	278.70		431099.8532	3974367.7467	74.21
4047	Black	277.00		431096.6225	3974322.0779	30.29
1249	Black	276.00		431066.9898	3974285.8673	17.58
1818	Black	276.00		431057.3127	3974263.0094	40.77
129	Black	275.00		431079.2293	3974289.2751	6.95
182	Black	275.00		431086.8214	3974306.7186	12.12
3840	Black	275.00		431067.0627	3974270.6171	29.05
3967	Black	275.00		431074.9189	3974267.7740	28.83
3788	Black	274.00		431065.5822	3974273.6284	27.31
3852	Black	274.00		431070.2970	3974270.9524	27.29
619	Black	271.50		431066.8105	3974249.6539	48.47
153	Black	270.00		431087.7121	3974290.1973	8.43
217	Black	270.00		431073.7831	3974289.1702	10.18
239	Black	270.00		431077.6543	3974286.1819	10.39
260	Black	270.00		431084.5679	3974284.1912	12.07
284	Black	270.00		431088.8473	3974311.7649	17.54
2140	Black	270.00		431064.2055	3974265.8122	34.64
3879	Black	270.00		431066.5954	3974268.5102	31.12
650	Black	269.70	p143	431113.0433	3974338.4942	53.06
1987	Black	269.00		431059.3050	3974274.3201	30.90
2122	Black	269.00		431062.8026	3974268.8108	32.85
3703	Black	269.00		431064.2926	3974275.8235	26.38
549	Black	268.10		431049.4486	3974253.2504	53.29
531	Black	267.30		431043.9024	3974255.1662	55.37
2200	Black	267.00		431060.0165	3974263.3132	38.97
474	Black	266.90		431075.1125	3974314.2062	19.42
70	Grey	265.00		431082.2384	3974303.3563	7.54
231	Black	265.00		431075.1996	3974284.5050	12.96
241	Black	265.00		431077.2597	3974284.9164	11.72
247	Black	265.00		431079.3481	3974286.0657	10.01
347	Black	265.00		431075.1390	3974282.2438	15.01
353	Black	265.00		431073.6945	3974279.5392	18.07
4154	Black	265.00		431090.0828	3974333.9610	39.07
424	Black	264.40		431064.4740	3974313.9499	24.82
1486	Black	263.00		431052.6933	3974254.9332	50.02
387	Black	262.90		431064.6709	3974320.5030	29.83
391	Black	262.30		431061.2205	3974330.5689	40.19
1927	Black	261.00		431061.6666	3974277.5451	26.96
220	Black	260.00		431073.8523	3974285.0071	13.25

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
312	Black	260.00		431068.9586	3974291.6077	13.20
316	Black	260.00		431068.8856	3974286.8234	15.48
590	Black	259.50		431054.7326	3974250.8487	52.34
1242	Black	259.00		431062.2897	3974286.4400	21.36
1741	Black	259.00		431055.6985	3974265.9566	39.47
445	Black	256.70		431073.1798	3974314.3125	20.23
1303	Black	256.00		431066.7900	3974310.8307	20.97
1765	Black	256.00		431055.5018	3974265.0041	40.32
120	Black	255.00		431078.6274	3974290.5132	6.05
128	Black	255.00		431079.5595	3974290.5857	5.60
149	Black	255.00		431083.2058	3974286.8145	9.21
238	Black	255.00		431078.3800	3974286.5698	9.78
315	Black	255.00		431068.7820	3974286.1782	15.95
328	Black	255.00		431072.1364	3974280.5048	17.96
2212	Black	254.00		431059.3244	3974261.6841	40.71
2251	Black	253.00		431062.8830	3974256.2599	43.74
1304	Black	252.00		431064.5607	3974309.0454	21.44
48	Black	250.00		431093.7377	3974298.0238	12.47
78	Black	250.00		431079.5931	3974302.9736	7.36
4310	Black	250.00		431052.9347	3974284.7057	30.63
1867	Black	248.00		431057.9250	3974259.9173	42.96
116	Black	245.00		431078.0049	3974291.3009	5.72
118	Black	245.00		431078.9974	3974291.4332	5.06
218	Black	245.00		431073.6186	3974286.6307	12.11
229	Black	245.00		431073.7845	3974283.6469	14.42
3965	Black	245.00		431074.2301	3974267.0878	29.66
3779	Black	244.00		431066.6480	3974273.2646	27.01
1784	Black	243.00		431054.7552	3974262.8565	42.45
386	Black	242.70		431064.1839	3974321.8252	31.19
2169	Black	242.00		431059.5485	3974265.8932	37.12
1414	Black	241.00		431048.4204	3974260.6812	48.26
4156	Black	241.00		431090.0097	3974332.7299	37.85
54	Grey	240.00		431090.5539	3974296.9024	9.15
64	Black	240.00		431085.3691	3974305.9794	10.85
362	Black	240.00		431079.5981	3974276.7751	19.17
380	Black	240.00		431072.1243	3974282.1089	16.62
2149	Black	240.00		431061.4931	3974264.5054	37.17
1435	Black	239.00		431048.5812	3974258.2470	49.95
1666	Black	239.00		431052.2410	3974268.7314	39.87

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
2143	Black	239.00		431061.9934	3974265.2705	36.25
3894	Black	239.00		431069.6613	3974266.9592	31.21
1265	Black	238.00		431073.9011	3974273.4222	23.67
3695	Black	238.00		431065.4644	3974277.0343	24.70
2009	Black	236.00		431063.4586	3974273.6026	28.62
4075	Black	236.00		431100.3847	3974331.6145	40.46
62	Black	235.00		431087.5971	3974305.1732	11.16
102	Black	235.00		431076.0391	3974291.8878	6.72
114	Black	235.00		431078.2056	3974291.6812	5.29
127	Black	235.00		431079.3895	3974290.7377	5.52
171	Black	235.00		431093.1382	3974290.9978	12.65
173	Black	235.00		431094.0054	3974293.3818	12.79
1812	Black	234.00		431054.8696	3974260.9008	43.92
4317	Black	234.00		431057.6386	3974288.8939	24.82
1283	Black	232.00		431104.3165	3974293.0833	23.02
2180	Black	232.00		431058.1537	3974264.9756	38.69
583	Black	230.10		431052.2677	3974245.9258	57.84
119	Black	230.00		431079.0851	3974291.4643	4.99
2080	Black	230.00		431059.9349	3974268.8409	34.54
3688	Black	230.00		431066.4098	3974277.5813	23.67
1946	Black	229.00		431063.8097	3974276.3453	26.31
544	Black	228.30		431044.7134	3974248.3523	60.06
1289	Black	226.00		431102.6751	3974308.8668	24.89
235	Black	225.00		431076.3895	3974286.3084	10.81
1453	Black	224.00		431049.1895	3974256.8125	50.65
461	Black	221.60		431072.3110	3974313.2865	19.69
581	Black	220.70		431050.8870	3974243.5452	60.59
236	Black	220.00		431077.6012	3974286.6245	10.00
266	Black	220.00		431093.5411	3974286.3473	15.37
355	Black	220.00		431074.6381	3974278.7254	18.44
651	Black	220.00		431111.1999	3974335.6700	49.70
576	Black	219.70		431054.2969	3974239.8021	62.29
3912	Black	219.00		431067.7487	3974265.5348	33.27
1267	Black	217.00		431074.6843	3974276.8642	20.16
2252	Black	217.00		431062.5267	3974255.8673	44.24
3902	Black	217.00		431064.6231	3974266.9818	33.42
607	Black	216.30		431058.5731	3974246.4039	54.49
2243	Black	216.00		431064.0358	3974260.9765	38.99
4030	Black	216.00		431104.4068	3974326.3898	38.20

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
852	Black	215.80		431039.7781	3974282.4195	43.79
132	Black	215.00		431079.6293	3974288.8539	7.23
245	Black	215.00		431076.5020	3974282.2650	14.46
255	Black	215.00		431082.7114	3974285.7742	10.16
264	Black	215.00		431094.5215	3974286.3547	16.15
294	Black	215.00		431076.8202	3974311.4682	16.29
1460	Black	214.00		431051.9480	3974258.7146	47.44
600	Black	213.60		431059.7766	3974250.6176	50.16
3976	Black	213.00		431102.4261	3974277.5187	27.85
79	Black	210.00		431077.9104	3974300.7445	6.04
244	Black	210.00		431075.5529	3974282.8770	14.26
1253	Black	210.00		431064.6976	3974279.4673	23.44
2230	Black	210.00		431062.7276	3974261.7166	38.94
601	Black	209.80		431060.8381	3974250.7990	49.55
2058	Black	208.00		431061.4453	3974270.6490	32.19
3906	Black	208.00		431065.1320	3974265.7316	34.26
1441	Black	207.00		431050.8513	3974259.3621	47.63
396	Black	206.80		431064.0764	3974334.3373	42.23
3863	Black	206.00		431065.1314	3974270.5661	30.10
37	Grey	205.00		431089.1635	3974294.4703	7.83
122	Black	205.00		431076.3886	3974289.4255	8.19
185	Black	205.00		431089.6968	3974309.5576	15.99
215	Black	205.00		431074.3972	3974289.3579	9.60
287	Black	205.00		431084.1175	3974312.4610	16.82
318	Black	205.00		431070.6333	3974285.8359	14.75
323	Black	205.00		431071.6218	3974283.3732	15.89
327	Black	205.00		431071.7916	3974280.6979	17.98
348	Black	205.00		431075.2044	3974281.1197	16.01
3898	Black	205.00		431067.4826	3974266.6146	32.41
477	Black	204.50		431073.5738	3974310.6158	16.74
1252	Black	204.00		431065.8553	3974280.0496	22.21
1487	Black	203.00		431052.4680	3974254.5137	50.49
1376	Black	203.00		431047.5405	3974264.2276	46.38
1585	Black	203.00		431055.9714	3974273.2074	34.10
2239	Black	203.00		431065.5742	3974262.0086	37.39
3896	Black	203.00		431067.6508	3974266.5746	32.37
4202	Black	203.00		431080.6882	3974324.4380	28.60
595	Black	202.30		431055.9337	3974251.7297	50.98
270	Black	200.00		431100.8215	3974289.5129	20.37

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
1649	Black	200.00		431056.8692	3974270.2760	35.48
1873	Black	200.00		431056.7544	3974259.7833	43.72
575	Black	196.40		431053.9253	3974238.9340	63.23
93	Black	195.00		431073.9419	3974294.7029	7.61
105	Black	195.00		431075.7737	3974290.9672	7.50
112	Black	195.00		431078.4795	3974292.9863	4.14
276	Black	195.00		431098.4580	3974307.0176	20.34
334	Black	195.00		431071.2703	3974284.6814	15.12
1425	Black	195.00		431051.2824	3974260.7529	46.29
1776	Black	195.00		431052.5552	3974261.5794	44.84
1422	Black	194.00		431050.9923	3974262.0531	45.51
3835	Black	194.00		431066.1272	3974271.6934	28.62
2223	Black	191.00		431060.4571	3974259.7547	41.76
41	Black	190.00		431091.6193	3974292.0704	10.84
92	Black	190.00		431074.0479	3974295.2699	7.44
227	Black	190.00		431074.9871	3974286.4603	11.41
250	Black	190.00		431078.8903	3974284.7534	11.39
358	Black	190.00		431078.4089	3974280.1641	15.98
1263	Black	190.00		431071.1894	3974276.8020	21.64
1789	Black	190.00		431055.2134	3974261.9833	42.85
4313	Black	190.00		431055.1953	3974287.5833	27.54
1261	Black	188.00		431071.0829	3974278.1106	20.55
1437	Black	188.00		431047.0043	3974258.3956	50.90
2256	Black	188.00		431064.8258	3974258.5790	40.82
1236	Black	187.00		431065.0207	3974284.8171	19.80
82	Black	185.00		431074.3612	3974301.6629	9.17
113	Black	185.00		431078.4543	3974291.8136	5.04
381	Black	185.00		431070.8706	3974278.6512	20.20
3716	Black	184.00		431066.3770	3974276.8641	24.25
1301	Black	183.00		431080.8736	3974320.4437	24.60
1817	Black	182.00		431057.3039	3974262.9343	40.83
1897	Black	182.00		431060.4287	3974258.8918	42.53
2018	Black	182.00		431064.4769	3974271.3670	29.80
42	Black	180.00		431092.0858	3974291.4889	11.49
214	Black	180.00		431074.6037	3974289.6097	9.27
1287	Black	180.00		431103.6748	3974307.6042	25.13
3680	Black	180.00		431064.7808	3974277.8599	24.54
3895	Black	180.00		431069.2154	3974267.0061	31.34
1259	Black	179.00		431069.8890	3974278.0102	21.27

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
1714	Black	179.00		431055.0512	3974267.6524	38.64
3831	Black	179.00		431067.9630	3974272.2775	27.17
663	Black	178.20		431102.8973	3974346.2937	54.81
1322	Black	178.00		431046.2925	3974277.3724	39.73
3892	Black	178.00		431070.1512	3974268.3335	29.75
1792	Black	177.00		431057.2580	3974265.4509	38.86
53	Black	175.00		431090.3366	3974296.3460	8.89
178	Black	175.00		431092.0849	3974304.0320	13.41
335	Black	175.00		431074.0914	3974282.8302	14.96
337	Black	175.00		431073.7480	3974281.2584	16.51
782	Black	174.40		431079.0211	3974340.7673	44.98
1266	Black	173.00		431075.0408	3974276.4403	20.45
1278	Black	173.00		431086.6919	3974275.9654	20.56
2087	Black	173.00		431058.6736	3974267.9044	36.06
3796	Black	173.00		431065.0934	3974272.9143	28.18
3909	Black	172.00		431065.3276	3974264.5188	35.24
1277	Black	171.00		431083.3756	3974271.2841	24.64
2019	Black	171.00		431064.5054	3974271.2614	29.87
65	Black	170.00		431083.5192	3974307.2465	11.58
186	Black	170.00		431087.4553	3974309.0477	14.49
366	Black	170.00		431080.6587	3974278.6607	17.21
1488	Black	170.00		431055.2195	3974252.7761	50.44
1239	Black	170.00		431064.0084	3974284.4000	20.88
397	Black	169.30		431056.5920	3974330.9695	43.03
415	Black	169.30		431063.2052	3974314.7550	26.28
50	Black	169.00		431094.0075	3974298.1638	12.76
649	Black	169.00		431114.2745	3974342.9010	57.36
1299	Black	169.00		431081.6333	3974322.3917	26.54
1430	Green	169.00		431049.7117	3974259.4682	48.29
751	Black	167.20		431092.6565	3974348.0926	53.43
1749	Black	167.00		431056.5202	3974267.4302	37.81
57	Grey	165.00		431089.7453	3974301.7636	10.18
1884	Black	164.00		431057.4651	3974256.7179	45.91
1892	Black	164.00		431059.8094	3974259.9641	41.91
2245	Black	164.00		431063.6695	3974259.8420	40.17
3872	Black	164.00		431066.8428	3974269.0208	30.56
596	Black	162.30		431055.2593	3974251.5688	51.46
1298	Black	161.00		431084.2327	3974322.3124	26.60
4057	Black	161.00		431102.2453	3974324.9378	35.75

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
81	Black	160.00		431075.6705	3974301.4726	8.07
84	Black	160.00		431075.2440	3974300.1809	7.58
115	Black	160.00		431078.3328	3974291.7021	5.20
184	Black	160.00		431086.5126	3974310.3590	15.36
222	Black	160.00		431074.4488	3974284.9849	12.93
228	Black	160.00		431074.8705	3974285.4467	12.32
232	Black	160.00		431075.4443	3974284.6017	12.76
265	Black	160.00		431094.0023	3974287.8078	14.90
3801	Black	160.00		431065.5546	3974272.5300	28.23
1237	Black	157.00		431064.4687	3974285.2187	20.05
2241	Black	157.00		431065.7547	3974260.2470	38.92
3883	Black	156.00		431065.3494	3974268.4522	31.79
4326	Black	156.00		431059.2737	3974284.1009	25.11
43	Black	155.00		431092.4161	3974292.0099	11.61
91	Black	155.00		431073.8351	3974296.7299	7.68
350	Black	155.00		431074.2648	3974280.6191	16.85
1878	Black	153.00		431054.1478	3974258.2395	46.48
1602	Black	152.00		431056.9415	3974273.1872	33.39
4148	Grey	152.00		431092.2166	3974331.5026	37.24
4369	Black	152.00		431061.9193	3974282.2912	23.79
1367	Black	151.00		431050.3451	3974265.2137	43.67
800	Black	150.80		431072.7942	3974338.3518	43.37
464	Black	150.50		431072.3218	3974312.1455	18.68
71	Grey	150.00		431081.9532	3974303.2428	7.41
243	Black	150.00		431076.7177	3974284.1671	12.61
251	Black	150.00		431078.5413	3974284.5485	11.68
292	Black	150.00		431076.1210	3974312.8589	17.82
339	Black	150.00		431073.3462	3974279.3224	18.42
4107	Black	150.00		431096.4581	3974327.6572	35.16
383	Black	149.50		431058.5556	3974318.3896	32.13
3811	Black	149.00		431068.5542	3974273.2948	25.99
1309	Black	147.00		431059.7651	3974299.3639	21.98
1900	Black	147.00		431058.9354	3974257.3606	44.60
2253	Black	147.00		431064.5882	3974254.4090	44.75
3958	Black	147.00		431077.9288	3974269.3302	26.76
1315	Black	146.00		431059.9907	3974290.1565	22.21
2063	Black	146.00		431062.4583	3974270.7580	31.48
146	Black	145.00		431082.6895	3974287.6499	8.29
351	Black	145.00		431074.1344	3974280.4657	17.04

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
360	Black	145.00		431079.2266	3974277.8535	18.14
1238	Black	145.00		431063.9520	3974285.0974	20.55
1291	Black	145.00		431096.5655	3974312.6232	22.57
1800	Black	145.00		431052.9888	3974259.8397	45.91
2198	Black	145.00		431059.9052	3974263.3212	39.03
1285	Black	144.00		431102.7900	3974304.7404	23.11
1918	Black	144.00		431059.3149	3974278.7510	27.98
1631	Black	143.00		431054.5048	3974270.3519	37.11
1451	Black	142.00		431050.2238	3974257.9110	49.15
1780	Black	141.00		431053.9897	3974261.4354	44.04
1905	Black	141.00		431060.6531	3974256.0517	44.91
2111	Black	141.00		431061.3548	3974266.9851	35.18
4061	Black	141.00		431102.1317	3974329.7379	39.69
392	Black	140.90		431062.9276	3974330.3418	39.15
494	Black	140.10		431125.4595	3974357.8233	76.00
223	Black	140.00		431074.4718	3974285.6373	12.38
230	Black	140.00		431074.7951	3974284.3357	13.31
246	Black	140.00		431079.5872	3974286.3746	9.66
372	Black	140.00		431068.4123	3974279.6268	20.82
1711	Black	139.00		431054.2662	3974267.4972	39.29
1903	Black	139.00		431059.1685	3974256.5337	45.20
566	Black	138.80		431046.0719	3974246.8214	60.47
1485	Black	138.00		431052.8458	3974254.6119	50.20
3944	Black	138.00		431071.7555	3974273.1521	24.69
4108	Black	138.00		431096.1923	3974327.2619	34.69
2238	Black	137.00		431065.4684	3974261.8679	37.56
4009	Grey	137.00		431099.0411	3974318.8010	28.91
4320	Black	137.00		431058.9288	3974285.2426	24.91
1826	Black	136.00		431056.9610	3974263.9455	40.23
94	Black	135.00		431074.1273	3974294.5851	7.44
1321	Black	134.00		431044.3489	3974278.4359	41.00
3830	Black	134.00		431068.7985	3974272.2352	26.80
433	Black	133.30		431068.5630	3974319.5403	26.97
3825	Black	133.00		431070.2452	3974272.0392	26.32
3917	Black	133.00		431067.2767	3974264.1576	34.72
837	Black	132.70		431043.0112	3974317.5522	44.15
622	Black	132.30		431070.2530	3974244.2518	52.80
744	Black	132.20		431086.1287	3974346.6765	51.04
1413	Black	132.00		431047.9746	3974260.3992	48.77

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
1462	Black	131.00		431053.0848	3974258.1406	47.20
3816	Black	131.00		431069.8983	3974274.6215	24.18
346	Black	130.00		431074.8173	3974282.4496	14.96
2249	Black	130.00		431060.9771	3974258.3421	42.74
4383	Black	130.00		431058.5228	3974281.5171	27.05
754	Black	129.50		431090.9010	3974358.0674	62.93
3934	Black	128.00		431082.7603	3974264.0101	31.87
4227	Black	128.00		431068.7801	3974323.9434	30.82
686	Black	127.80		431105.7827	3974353.5827	62.64
4286	Black	127.00		431054.8242	3974295.7214	26.64
1262	Black	126.00		431070.8906	3974277.9605	20.78
59	Black	125.00		431087.8970	3974303.9808	10.37
201	Black	125.00		431072.2166	3974302.5191	11.40
375	Black	125.00		431069.1503	3974276.0337	23.33
2048	Black	125.00		431058.8780	3974269.4100	34.77
554	Black	124.90		431050.1367	3974252.0138	53.88
1279	Black	124.00		431086.4105	3974275.3716	21.07
3874	Black	124.00		431069.3215	3974269.7594	28.78
4016	Black	124.00		431103.9412	3974321.0444	33.76
1798	Black	123.00		431055.7362	3974263.7563	41.13
2132	Black	123.00		431062.3397	3974266.9696	34.64
3836	Black	123.00		431066.3281	3974271.6397	28.55
1662	Black	122.00		431053.3344	3974269.5725	38.49
1910	Black	122.00		431059.2891	3974253.4638	47.84
4072	Black	122.00		431101.6652	3974333.3303	42.58
4344	Black	122.00		431062.2082	3974284.0954	22.56
1243	Black	121.00		431067.6253	3974282.9865	18.89
1446	Black	121.00		431051.6103	3974259.3080	47.19
2227	Black	121.00		431061.1635	3974259.9979	41.20
4014	Black	121.00		431103.8072	3974320.7550	33.46
85	Black	120.00		431075.3850	3974299.2782	6.98
181	Black	120.00		431088.7247	3974305.5080	12.08
352	Black	120.00		431073.8736	3974280.4037	17.21
1854	Black	120.00		431058.4925	3974262.5952	40.42
2096	Black	120.00		431059.4911	3974266.8432	36.39
3683	Black	120.00		431065.8141	3974278.5040	23.36
2069	Black	119.00		431064.0278	3974270.0553	31.14
1791	Black	118.00		431055.4884	3974263.1142	41.79
4246	Black	118.00		431051.2843	3974311.0833	33.80

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
568	Black	117.70		431047.0987	3974244.1612	62.07
3881	Black	117.00		431065.8746	3974268.4092	31.56
543	Black	116.60		431044.8591	3974251.3357	57.63
1296	Black	116.00		431091.7883	3974316.0925	22.72
1925	Black	116.00		431060.9931	3974278.7266	26.69
1971	Black	116.00		431063.8488	3974274.1908	27.92
1972	Black	116.00		431064.2973	3974274.2096	27.62
192	Black	115.00		431076.7743	3974306.6522	11.77
224	Black	115.00		431074.5437	3974285.7141	12.27
262	Black	115.00		431093.7375	3974286.1153	15.67
356	Black	115.00		431077.4621	3974278.2468	18.05
1251	Black	115.00		431065.7427	3974279.1601	22.93
3782	Black	115.00		431066.3206	3974273.3056	27.16
3823	Black	115.00		431069.9116	3974272.5773	25.98
4170	Grey	115.00		431086.8093	3974320.9812	25.69
402	Black	114.00		431067.7642	3974319.1623	27.04
4386	Black	114.00		431058.3874	3974280.8442	27.53
704	Black	113.40		431096.9638	3974360.7486	66.72
1526	Black	113.00		431054.9018	3974277.7443	32.15
1762	Black	113.00		431055.8574	3974265.0620	40.05
2141	Black	113.00		431063.6471	3974264.9299	35.69
1458	Black	112.00		431050.8483	3974257.5361	49.04
3919	Black	112.00		431066.2513	3974262.5979	36.57
4387	Black	112.00		431058.3706	3974280.6715	27.63
422	Black	111.60		431063.5242	3974312.7835	24.67
1525	Black	111.00		431052.0707	3974275.9756	35.48
1853	Black	111.00		431057.7129	3974261.9884	41.36
4160	Black	111.00		431088.0985	3974327.9814	32.81
329	Black	110.00		431072.3372	3974280.8320	17.57
3928	Black	110.00		431068.3498	3974259.8524	38.31
1361	Black	108.00		431050.4634	3974266.6851	42.56
2043	Black	108.00		431058.0763	3974270.6661	34.37
3866	Black	108.00		431066.3178	3974270.1634	29.82
594	Black	107.60		431056.6389	3974250.2059	51.96
707	Black	107.50		431095.5516	3974351.4920	57.40
1431	Black	107.00		431049.3430	3974259.2920	48.67
1868	Black	107.00		431057.7715	3974259.7487	43.18
2015	Black	107.00		431064.3349	3974273.1086	28.47
2205	Black	107.00		431060.5631	3974263.7910	38.27

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
599	Black	106.50		431059.9291	3974251.3966	49.40
242	Black	105.00		431076.7859	3974284.4864	12.29
1335	Black	105.00		431046.2808	3974272.6730	42.13
4305	Black	105.00		431052.8143	3974287.3782	29.87
1336	Black	104.00		431046.1722	3974272.5041	42.31
1452	Black	104.00		431049.9753	3974257.4136	49.69
1815	Black	104.00		431056.5191	3974262.7266	41.47
3957	Black	104.00		431072.4296	3974271.3668	26.10
3961	Black	104.00		431071.8989	3974269.0129	28.49
4055	Black	104.00		431102.0697	3974325.6763	36.25
501	Black	103.30		431107.2634	3974367.0537	75.73
539	Black	103.10		431036.5447	3974246.7123	66.58
1658	Black	103.00		431055.3740	3974269.0528	37.40
1965	Black	103.00		431062.6629	3974275.1460	27.97
3899	Black	103.00		431067.0168	3974266.4907	32.72
527	Black	102.90		431037.1860	3974251.3047	62.81
2028	Black	102.00		431061.6574	3974271.6778	31.25
1419	Black	101.00		431050.4511	3974261.5965	46.21
1598	Black	101.00		431058.4252	3974273.7987	31.89
1627	Black	101.00		431054.1814	3974270.9476	36.94
2146	Black	101.00		431061.8303	3974265.7277	35.96
442	Black	100.50		431072.6327	3974315.8741	21.88
45	Black	100.00	black and grey	431092.0861	3974294.4746	10.71
47	Black	100.00		431091.7191	3974295.0102	10.29
1373	Black	99.00		431048.4296	3974265.1698	45.08
1383	Black	99.00		431039.6304	3974263.5657	52.84
2228	Black	99.00		431062.0826	3974261.2170	39.69
2255	Black	99.00		431064.9719	3974258.0070	41.28
3797	Black	99.00		431065.2181	3974272.8666	28.15
636	Black	98.70		431118.5201	3974335.3566	54.17
407	Black	98.50		431060.6791	3974315.9504	28.91
1426	Black	98.00		431050.3401	3974260.6120	47.02
1628	Black	98.00		431054.1278	3974270.7850	37.09
741	Black	97.80		431088.3678	3974343.1205	47.77
1461	Black	97.00		431052.5006	3974259.0420	46.84
1825	Black	97.00		431056.8551	3974264.1146	40.16
3802	Black	97.00		431065.9293	3974272.2953	28.22
4340	Black	97.00		431060.9921	3974284.9753	23.18
1421	Black	96.00		431050.6191	3974261.3976	46.24

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
1580	Black	96.00		431054.6464	3974272.7180	35.42
657	Black	95.80		431104.7848	3974336.5687	46.92
86	Black	95.00		431077.4197	3974298.4390	4.80
267	Black	95.00		431093.4969	3974289.0389	13.83
374	Black	95.00		431068.8707	3974276.3600	23.21
1366	Black	95.00		431051.1146	3974265.4034	42.99
2214	Black	95.00		431059.4118	3974261.4928	40.83
2231	Black	95.00		431062.8757	3974261.8962	38.71
2137	Black	95.00		431063.6765	3974266.7390	34.12
2139	Black	95.00		431063.9284	3974265.8310	34.77
839	Black	94.60		431044.3468	3974317.4577	42.94
1302	Black	94.00		431082.3594	3974320.4607	24.62
2105	Black	94.00		431060.3674	3974266.8501	35.86
467	Black	93.70		431072.9353	3974310.1964	16.69
1599	Black	93.00		431058.3649	3974273.6190	32.06
1313	Black	92.00		431060.8284	3974295.3896	20.64
1976	Black	92.00		431063.4788	3974273.8676	28.40
2073	Black	92.00		431061.6531	3974269.1596	33.24
540	Black	90.70		431037.2224	3974242.5627	69.26
1788	Black	90.00		431054.8792	3974262.5445	42.62
2103	Black	90.00		431059.9458	3974267.2234	35.81
3869	Black	90.00		431065.7935	3974269.6178	30.56
3995	Black	90.00		431111.4904	3974323.4946	40.81
500	Black	89.20		431111.0256	3974373.8613	83.42
522	Black	89.10		431028.3037	3974252.9796	68.29
1245	Black	89.00		431066.6331	3974282.1879	20.16
2131	Black	89.00		431062.5491	3974267.8896	33.76
3999	Black	89.00		431102.3809	3974316.3692	29.30
495	Black	88.80		431126.4778	3974362.9986	80.84
4043	Black	88.00		431094.2212	3974319.5270	26.89
4076	Black	88.00		431099.3651	3974332.6319	40.91
794	Black	87.20		431073.8747	3974365.2822	69.84
1457	Black	87.00		431048.8482	3974255.3593	51.99
1689	Black	87.00		431057.0749	3974269.7341	35.73
4266	Black	87.00		431056.9920	3974303.5679	25.66
1782	Black	86.00		431054.4273	3974262.1186	43.23
2064	Black	86.00		431062.4522	3974270.9493	31.33
4238	Black	86.00		431053.8073	3974313.5318	32.82
2165	Black	85.00		431058.4895	3974266.4736	37.29

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
3768	Black	85.00		431068.8916	3974275.3101	24.08
3911	Black	85.00		431066.8906	3974265.4054	33.75
1752	Black	84.00		431057.4828	3974267.5901	37.06
3923	Black	83.00		431072.6371	3974263.1708	33.85
2209	Black	82.00		431061.5787	3974262.7007	38.66
676	Black	81.50		431100.5852	3974335.3234	43.86
552	Black	81.40		431048.2667	3974251.0214	55.78
1508	Black	81.00		431057.8500	3974278.7334	29.16
4262	Black	81.00		431057.8425	3974306.9522	26.10
438	Black	80.60		431071.5298	3974317.9857	24.26
4296	Black	80.00		431056.1274	3974294.5457	25.37
4372	Black	80.00		431060.7500	3974282.6937	24.54
459	Black	79.60		431065.2398	3974310.9980	22.19
703	Black	79.60		431099.2451	3974356.9507	63.63
1849	Black	79.00		431056.9906	3974261.1033	42.50
1904	Black	79.00		431060.6017	3974256.3083	44.71
3970	Black	79.00		431087.7270	3974267.5005	29.04
4082	Black	79.00		431100.5323	3974326.6581	36.23
534	Black	78.20		431042.0480	3974255.1761	56.64
1777	Black	78.00		431053.1142	3974261.3608	44.65
1899	Black	78.00		431059.6040	3974257.8460	43.84
4306	Black	78.00		431052.9363	3974286.5737	30.00
547	Black	77.50		431047.0470	3974253.7523	54.38
597	Black	77.50		431058.3235	3974250.4120	50.99
1248	Black	77.00		431066.4978	3974286.2263	17.79
1623	Black	77.00		431052.5735	3974269.7830	38.91
2118	Black	77.00		431062.9189	3974268.8322	32.77
652	Black	76.40		431110.4102	3974338.5844	51.61
1400	Black	76.00		431051.2373	3974264.0146	43.90
1955	Black	76.00		431059.2245	3974277.2282	29.01
2014	Black	76.00		431064.0910	3974273.8061	28.07
2199	Black	76.00		431059.8762	3974263.1076	39.22
4100	Black	76.00		431098.7857	3974326.9279	35.58
498	Black	75.70		431129.8950	3974390.0592	105.93
476	Black	75.10		431073.1894	3974311.8787	18.03
58	Black	75.00		431087.9274	3974303.4338	9.96
376	Black	75.00		431069.1893	3974277.3319	22.22
1728	Black	75.00		431053.6204	3974263.8049	42.45
1804	Black	75.00		431053.4331	3974259.6887	45.75

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
1443	Black	74.00		431051.7127	3974259.8539	46.70
1760	Black	74.00		431056.0583	3974265.4760	39.60
1794	Black	74.00		431056.5783	3974264.9576	39.67
1813	Black	74.00		431054.8589	3974261.0138	43.83
2248	Black	74.00		431061.5021	3974258.3614	42.47
2112	Black	74.00		431061.5310	3974268.1523	34.13
2191	Black	74.00		431061.2956	3974263.7077	37.95
4164	Black	74.00		431086.7762	3974325.7573	30.37
2215	Black	73.00		431059.8700	3974260.9433	41.05
2128	Black	73.00		431063.0830	3974267.9735	33.39
2134	Black	73.00		431063.0666	3974267.0192	34.20
588	Black	72.50		431053.0853	3974251.5454	52.62
1323	Black	72.00		431046.6552	3974277.3476	39.42
1852	Black	72.00		431057.4998	3974261.9730	41.50
2119	Black	72.00		431062.9534	3974268.8476	32.74
4175	Black	72.00		431086.0270	3974323.2723	27.80
556	Black	71.10		431051.6780	3974252.3334	52.74
1467	Black	71.00		431053.5078	3974257.5251	47.44
4176	Black	71.00		431084.6551	3974323.6091	27.94
533	Black	70.80		431042.6210	3974255.4525	56.04
419	Black	70.60		431061.0492	3974312.9086	26.60
666	Black	70.30		431108.2744	3974348.7791	59.33
248	Black	70.00		431079.1421	3974285.5311	10.58
367	Black	70.00		431080.6928	3974279.1075	16.76
661	Black	70.00		431103.8606	3974344.8850	53.91
1489	Black	70.00		431054.8471	3974252.8085	50.61
2078	Black	70.00		431060.5473	3974268.7394	34.24
3744	Black	70.00		431065.6686	3974274.5717	26.50
4396	Black	70.00		431064.7426	3974279.3978	23.46
475	Black	69.20		431073.8380	3974312.0175	17.87
1394	Black	69.00		431048.4484	3974262.9827	46.59
1865	Black	69.00		431058.6883	3974260.5195	42.04
3764	Black	69.00		431067.4122	3974275.1401	25.03
3948	Black	69.00		431070.5793	3974270.3690	27.71
3962	Black	69.00		431072.7415	3974268.6207	28.59
530	Black	68.50		431045.2204	3974255.9303	53.92
849	Black	68.10		431019.9823	3974297.7487	61.51
1411	Black	68.00		431047.5157	3974260.5335	48.99
1797	Black	68.00		431056.3798	3974264.5673	40.10

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
2095	Black	68.00		431059.7645	3974267.3825	35.80
3772	Black	68.00		431067.6791	3974274.6280	25.31
736	Black	67.70		431086.9975	3974338.4671	42.97
446	Black	67.10		431073.4302	3974314.3710	20.18
1254	Black	67.00		431068.6809	3974278.0353	21.93
1403	Black	67.00		431051.6695	3974264.5787	43.19
3789	Black	67.00		431065.3508	3974273.8309	27.29
694	Black	66.20		431103.0244	3974363.4569	70.96
1475	Black	66.00		431051.1716	3974254.1828	51.52
1429	Black	66.00		431050.5019	3974259.6137	47.66
2142	Black	66.00		431062.5917	3974264.7677	36.36
319	Black	65.00		431070.8400	3974285.5987	14.76
1594	Black	65.00		431058.1780	3974274.5762	31.54
2152	Black	65.00		431060.4950	3974265.1923	37.14
3676	Black	65.00		431064.3569	3974278.3784	24.45
1697	Black	64.00		431052.4908	3974266.3392	41.36
2054	Black	64.00		431060.1612	3974270.1306	33.40
3920	Black	64.00		431066.4201	3974262.1582	36.90
4146	Grey	64.00		431090.1267	3974327.3177	32.64
4356	Black	64.00		431064.8779	3974279.9609	22.97
834	Black	63.30		431032.6764	3974334.0878	61.98
831	Black	63.10		431046.8193	3974340.8180	56.76
1368	Black	63.00		431050.1556	3974264.9725	43.97
1393	Black	63.00		431049.1013	3974263.2742	45.92
1587	Black	63.00		431056.5494	3974273.4833	33.48
1810	Black	63.00		431054.4446	3974260.5184	44.48
1990	Black	63.00		431060.2344	3974274.1199	30.38
2067	Black	63.00		431064.4398	3974270.6161	30.44
639	Black	62.60		431115.0430	3974334.4227	51.14
499	Black	62.40		431113.0525	3974367.3155	78.13
1521	Black	62.00		431053.3185	3974277.3213	33.70
1260	Black	62.00		431070.2566	3974278.1221	20.97
1733	Black	62.00		431054.5812	3974265.0586	40.88
1850	Black	62.00		431057.1129	3974261.0727	42.46
1957	Black	62.00		431059.2042	3974276.4290	29.54
4039	Black	62.00		431099.2186	3974322.2917	31.85
4126	Grey	62.00		431094.7143	3974332.8285	39.28
4360	Black	62.00		431065.2603	3974279.8212	22.79
550	Black	61.50		431049.0493	3974252.4470	54.17

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
805	Black	61.20		431069.7146	3974337.7629	43.53
3753	Black	61.00		431067.4492	3974276.8900	23.58
4398	Black	61.00		431065.1966	3974279.1992	23.28
690	Black	60.20		431104.4922	3974366.8417	74.63
1729	Black	60.00		431053.6995	3974264.0793	42.19
1786	Black	60.00		431054.8383	3974262.4985	42.68
1926	Black	60.00		431061.8695	3974278.8882	25.92
1937	Black	60.00		431063.3765	3974277.9331	25.46
2070	Black	60.00		431063.4232	3974269.9934	31.53
2216	Black	60.00		431060.3037	3974260.8993	40.86
2150	Black	60.00		431061.0626	3974264.5572	37.36
4008	Black	60.00		431100.0286	3974319.7655	30.27
4040	Black	60.00		431099.1032	3974322.5935	32.04
4067	Grey	60.00		431101.0009	3974327.7030	37.37
4221	Black	60.00		431072.9863	3974322.9939	28.43
4263	Black	60.00		431058.8389	3974305.8022	24.71
4321	Black	60.00		431059.1396	3974285.0705	24.79
1569	Black	59.00		431056.3645	3974275.1524	32.53
1802	Black	59.00		431053.1314	3974259.3986	46.17
1863	Black	59.00		431058.9906	3974260.9416	41.52
1986	Black	59.00		431059.8841	3974274.4754	30.37
2240	Black	59.00		431065.9716	3974260.8942	38.24
2166	Black	59.00		431058.6071	3974266.0873	37.53
3723	Black	59.00		431066.6979	3974275.8738	24.84
4230	Black	59.00		431070.1112	3974328.9916	35.03
4338	Black	59.00		431061.2841	3974285.0903	22.87
439	Black	58.70		431068.9960	3974315.3328	23.13
390	Black	58.40		431059.5481	3974329.7141	40.33
1647	Black	58.00		431057.3554	3974270.6804	34.85
1700	Black	58.00		431052.1106	3974265.4217	42.28
2181	Black	58.00		431058.2399	3974264.5479	38.98
2194	Black	58.00		431063.4227	3974264.1191	36.50
518	Black	57.90		431021.3659	3974305.7407	60.90
1476	Black	57.00		431051.1601	3974254.8120	51.01
1660	Black	57.00		431054.5213	3974269.2132	37.89
1699	Black	57.00		431051.6809	3974265.7664	42.33
1736	Black	57.00		431054.7280	3974266.1865	39.93
1901	Black	57.00		431058.4839	3974257.8331	44.42
1909	Black	57.00		431058.3599	3974253.5073	48.24

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
1996	Black	57.00		431059.3362	3974273.1089	31.73
3774	Black	57.00		431067.1551	3974273.9761	26.14
3891	Black	57.00		431067.1446	3974267.1829	32.05
3990	Black	57.00		431103.8909	3974313.1015	28.29
4031	Black	57.00		431104.1928	3974327.6019	39.05
4172	Black	57.00		431086.7922	3974321.4215	26.12
4174	Black	57.00		431086.3707	3974322.0501	26.65
563	Black	56.10		431047.6642	3974248.5171	58.16
1920	Black	56.00		431059.9073	3974278.8833	27.43
2154	Black	56.00		431060.1989	3974265.4955	37.06
3968	Black	56.00		431081.1938	3974270.3345	25.52
641	Black	55.90		431120.7923	3974346.6978	64.28
656	Black	55.90		431106.4578	3974335.3827	46.77
55	Grey	55.00		431090.7799	3974296.9104	9.38
1747	Black	55.00		431056.2975	3974266.8651	38.39
1883	Black	55.00		431057.1883	3974256.8441	45.94
4032	Grey	55.00		431103.9042	3974327.7576	39.01
425	Black	54.30		431064.5077	3974314.9724	25.55
454	Black	54.30		431067.7985	3974312.5945	21.61
1386	Black	54.00		431040.5580	3974261.0400	53.71
1716	Black	54.00		431055.7636	3974267.4656	38.29
1773	Black	54.00		431053.7609	3974263.0862	42.91
1906	Black	54.00		431058.1389	3974256.2376	45.97
1949	Black	54.00		431062.0455	3974276.2627	27.58
2136	Black	54.00		431063.6984	3974267.7398	33.25
3829	Black	54.00		431069.5816	3974271.7694	26.85
4069	Black	54.00		431102.4880	3974334.3616	43.88
1405	Black	53.00		431050.2172	3974262.4859	45.71
2049	Black	53.00		431058.8714	3974270.2615	34.14
3751	Black	53.00		431066.5545	3974274.7286	25.85
3904	Black	53.00		431065.0627	3974266.1446	33.93
3916	Black	53.00		431068.8979	3974263.7900	34.44
836	Black	52.20		431033.3742	3974320.9843	54.26
653	Black	52.10		431111.9047	3974338.4341	52.34
593	Black	52.00		431055.6697	3974250.3530	52.30
1568	Black	52.00		431056.3290	3974275.1278	32.58
1856	Black	52.00		431057.8910	3974263.3050	40.19
1872	Black	52.00		431056.9586	3974259.6697	43.70
2045	Black	52.00		431058.5315	3974270.2145	34.40

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
2120	Black	52.00		431062.7635	3974268.8945	32.81
2185	Black	52.00		431059.3241	3974265.0306	37.95
1625	Black	51.00		431053.7053	3974271.3563	37.02
1785	Black	51.00		431054.7856	3974262.5251	42.69
2193	Black	51.00		431062.3444	3974263.7263	37.38
343	Other	50.00	rebar	431073.9351	3974278.5418	18.88
1412	Black	50.00		431047.8933	3974260.5875	48.69
1466	Black	50.00		431053.6755	3974257.6677	47.22
2023	Black	50.00		431062.8027	3974271.5030	30.68
2091	Black	50.00		431058.2518	3974267.3843	36.73
4083	Black	50.00		431099.9678	3974326.2734	35.61
4336	Black	50.00		431060.2244	3974287.3446	22.88
4352	Black	50.00		431064.4430	3974280.3593	23.01
1334	Black	49.00		431046.5770	3974273.4149	41.48
1567	Black	49.00		431056.1458	3974275.1047	32.73
1755	Black	49.00		431057.3346	3974266.7613	37.79
2071	Black	49.00		431062.6532	3974269.6089	32.29
2079	Black	49.00		431060.2302	3974268.7086	34.46
2081	Black	49.00		431058.9298	3974268.6760	35.30
2117	Black	49.00		431062.5685	3974269.0722	32.77
2160	Black	49.00		431059.5901	3974266.8583	36.32
2204	Black	49.00		431058.8128	3974263.7169	39.32
4036	Grey	49.00		431101.4042	3974323.9255	34.44
4229	Black	49.00		431070.2242	3974326.5451	32.68
813	Black	48.70		431063.0225	3974359.2985	66.07
532	Black	48.60		431044.5193	3974254.7560	55.26
403	Black	48.40		431065.5697	3974320.9139	29.67
1381	Black	48.00		431043.1526	3974263.2123	50.33
1382	Black	48.00		431041.3593	3974262.9527	51.87
1449	Black	48.00		431051.0395	3974258.6278	48.07
1764	Black	48.00		431055.6472	3974265.3857	39.93
1941	Black	48.00		431064.0413	3974278.3312	24.71
2220	Black	48.00		431060.4712	3974261.8655	39.95
3940	Black	48.00		431074.5001	3974272.0179	24.83
4088	Grey	48.00		431092.2966	3974321.4072	27.76
4121	Grey	48.00		431095.2120	3974329.7897	36.62
4135	Grey	48.00		431092.0387	3974326.8317	32.73
1562	Black	47.00		431056.2985	3974275.9423	32.09
1724	Black	47.00		431052.3988	3974263.4946	43.49

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
1756	Black	47.00		431057.3141	3974266.8972	37.70
1823	Black	47.00		431056.7867	3974264.1886	40.14
1940	Black	47.00		431063.7576	3974278.5834	24.73
2027	Black	47.00		431061.9417	3974271.4891	31.22
2162	Black	47.00		431059.2918	3974266.9364	36.44
4359	Black	47.00		431065.1170	3974279.7983	22.91
642	Black	46.10		431117.0483	3974349.4958	64.37
1975	Black	46.00		431063.6710	3974273.9787	28.20
2059	Black	46.00		431061.3252	3974271.0562	31.94
2210	Black	46.00		431059.3259	3974262.4225	40.09
2170	Black	46.00		431059.8757	3974265.6047	37.16
3845	Black	46.00		431068.3790	3974270.6117	28.43
3858	Black	46.00		431066.0984	3974270.8838	29.32
4042	Grey	46.00		431096.3982	3974319.1058	27.64
4048	Black	46.00		431096.8239	3974322.4881	30.75
807	Black	45.10		431071.2413	3974344.5442	49.75
1396	Black	45.00		431049.6651	3974263.1689	45.60
1455	Black	45.00		431047.1938	3974255.2299	53.15
1614	Black	45.00		431054.1902	3974271.7107	36.42
1882	Black	45.00		431057.0399	3974256.4096	46.39
2003	Black	45.00		431061.8136	3974273.9507	29.42
2133	Black	45.00		431062.7359	3974266.9281	34.46
2151	Black	45.00		431060.6660	3974264.7021	37.45
3952	Black	45.00		431073.6778	3974271.2077	25.85
3977	Black	45.00		431103.7693	3974277.1716	29.10
1707	Black	44.00		431054.4490	3974266.3254	40.02
1758	Black	44.00		431056.6223	3974265.9389	38.88
1803	Black	44.00		431053.5181	3974259.6325	45.75
1881	Black	44.00		431056.3526	3974255.9984	47.10
2033	Black	44.00		431060.9236	3974272.7354	30.92
3847	Black	44.00		431069.9380	3974271.5746	26.87
4071	Grey	44.00		431102.6845	3974333.2957	43.04
535	Black	43.80		431041.3350	3974253.4825	58.36
698	Black	43.10		431103.1792	3974358.9010	66.68
1960	Black	43.00		431061.3002	3974276.0639	28.25
2101	Black	43.00		431059.8980	3974267.6973	35.46
15	Black	42.80		431023.0083	3974324.9185	65.28
1973	Black	42.00		431063.9668	3974274.1219	27.90
2011	Black	42.00		431063.7523	3974273.4836	28.53

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
2236	Black	42.00		431063.9309	3974263.0272	37.21
3833	Black	42.00		431067.2531	3974271.8749	27.87
4361	Black	42.00		431065.1563	3974279.6731	22.97
4397	Black	42.00		431064.7657	3974279.2790	23.53
644	Black	41.10		431119.6764	3974356.4651	71.65
1517	Black	41.00		431051.9032	3974277.0266	35.04
1360	Black	41.00		431050.3335	3974268.0002	41.77
1698	Black	41.00		431052.0688	3974266.0021	41.89
1787	Black	41.00		431054.8972	3974262.4556	42.67
1795	Black	41.00		431056.5869	3974264.7989	39.79
1809	Black	41.00		431054.4384	3974260.3936	44.58
3913	Black	41.00		431069.2386	3974265.9741	32.28
4013	Grey	41.00		431102.3774	3974320.7026	32.48
4233	Black	41.00		431068.7794	3974331.0614	37.42
332	Black	40.00		431072.9652	3974282.6459	15.70
1350	Black	40.00		431044.8608	3974267.1856	46.49
1691	Black	40.00		431055.0784	3974268.2958	38.15
1828	Black	40.00		431057.4012	3974264.7220	39.34
1836	Black	40.00		431055.9739	3974261.2092	43.01
2147	Black	40.00		431061.7508	3974265.0104	36.60
3951	Black	40.00		431072.2657	3974269.7513	27.67
3981	Black	40.00		431107.5061	3974275.3070	33.17
3986	Black	40.00		431131.7378	3974317.2447	54.64
4007	Black	40.00		431101.1148	3974318.9492	30.33
4235	Black	40.00		431065.3569	3974324.4568	32.83
4358	Black	40.00		431064.9718	3974279.7095	23.08
818	Black	39.70		431071.2441	3974333.6382	39.14
388	Black	39.20		431055.5523	3974329.0980	42.15
1518	Black	39.00		431051.6087	3974276.8652	35.38
1332	Black	39.00		431042.4542	3974273.6356	44.89
1380	Black	39.00		431044.6817	3974264.3636	48.42
1731	Black	39.00		431053.7677	3974264.6192	41.74
3675	Black	39.00		431064.6800	3974278.3567	24.24
4223	Black	39.00		431071.4369	3974321.0341	27.10
4252	Black	39.00		431058.3640	3974310.7668	27.49
700	Black	38.80		431098.8409	3974351.2285	58.04
738	Black	38.30		431087.5238	3974341.6082	46.16
1377	Black	38.00		431046.5895	3974265.4116	46.29
1717	Black	38.00		431055.9470	3974267.5686	38.09

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
1895	Black	38.00		431059.8991	3974260.5463	41.37
2006	Black	38.00		431062.4906	3974273.3598	29.42
2235	Black	38.00		431063.5837	3974263.0343	37.37
3943	Black	38.00		431073.1863	3974272.0336	25.22
400	Black	37.20		431065.4117	3974322.2693	30.91
1378	Black	37.00		431046.6291	3974264.5698	46.82
1793	Black	37.00		431056.7059	3974265.2152	39.39
2114	Black	37.00		431061.9223	3974268.5951	33.54
3828	Black	37.00		431069.7720	3974272.0466	26.52
3945	Black	37.00		431071.0201	3974273.3868	24.77
764	Black	36.70		431080.7785	3974355.6446	59.80
524	Black	36.20		431038.2268	3974257.8636	57.55
382	Black	36.10		431059.4585	3974318.0052	31.22
1772	Black	36.00		431054.1236	3974263.0336	42.71
2044	Black	36.00		431058.4583	3974270.6860	34.10
2123	Black	36.00		431062.6126	3974268.3158	33.37
2192	Black	36.00		431061.5211	3974263.7117	37.82
3839	Black	36.00		431067.5866	3974270.9950	28.47
4027	Black	36.00		431106.7893	3974329.4779	42.10
4110	Grey	36.00		431094.7875	3974325.3051	32.33
4323	Black	36.00		431058.7565	3974284.4536	25.41
838	Black	35.10		431044.2656	3974316.8361	42.71
268	Black	35.00		431094.0204	3974289.2600	14.18
1843	Black	35.00		431056.3830	3974260.5701	43.29
1855	Black	35.00		431058.1240	3974263.1098	40.21
1871	Black	35.00		431057.0884	3974260.0106	43.34
2026	Black	35.00		431062.1673	3974271.4428	31.11
2057	Black	35.00		431060.9387	3974270.7027	32.46
2148	Black	35.00		431061.5216	3974265.0032	36.73
3712	Black	35.00		431065.7659	3974276.3876	25.00
3739	Black	35.00		431064.8053	3974274.2564	27.27
3985	Black	35.00		431106.9682	3974308.6445	28.53
4136	Grey	35.00		431091.4424	3974325.6773	31.45
4159	Black	35.00		431088.0075	3974329.9111	34.68
4204	Grey	35.00		431081.8460	3974325.6663	29.82
655	Black	34.80		431109.0618	3974341.3888	53.25
462	Black	34.70		431072.5722	3974312.5293	18.90
643	Black	34.40		431117.4694	3974353.9215	68.33
418	Black	34.10		431061.6053	3974313.3112	26.44

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
620	Black	34.00		431067.4231	3974249.6656	48.27
1479	Black	34.00		431054.0583	3974255.8444	48.49
1354	Black	34.00		431047.0978	3974266.7418	45.04
1436	Black	34.00		431048.1038	3974258.2591	50.26
1570	Black	34.00		431056.2475	3974275.6321	32.32
1615	Black	34.00		431054.0352	3974271.7842	36.49
1678	Black	34.00		431052.5650	3974266.8579	40.94
1759	Black	34.00		431056.1808	3974265.4626	39.53
1844	Black	34.00		431056.2899	3974260.7576	43.19
1915	Black	34.00		431059.4093	3974280.0174	27.15
2025	Black	34.00		431062.4307	3974271.2256	31.12
2047	Black	34.00		431059.1730	3974270.3333	33.88
2092	Black	34.00		431059.1154	3974267.7145	35.93
2177	Black	34.00		431060.3048	3974264.4609	37.86
3842	Black	34.00		431067.3716	3974270.5187	28.99
4026	Grey	34.00		431107.3261	3974331.7011	44.20
4046	Grey	34.00		431096.0209	3974321.5396	29.53
4242	Black	34.00		431058.7372	3974313.2406	28.61
431	Black	33.70		431068.2126	3974317.8937	25.72
739	Black	33.20		431086.5749	3974342.4857	46.91
1391	Black	33.00		431047.2997	3974263.2649	47.21
1415	Black	33.00		431049.9014	3974260.8131	47.16
1633	Black	33.00		431054.8824	3974271.3815	36.13
1661	Black	33.00		431053.6745	3974269.0466	38.61
1753	Black	33.00		431057.9824	3974267.0613	37.15
1816	Black	33.00		431056.8222	3974263.1815	40.92
1885	Black	33.00		431057.4625	3974257.0044	45.66
1938	Black	33.00		431063.3846	3974277.9658	25.43
2038	Black	33.00		431060.7136	3974271.5765	31.93
2217	Black	33.00		431060.0080	3974260.5058	41.35
2202	Black	33.00		431059.4466	3974263.2174	39.37
4224	Black	33.00		431072.0242	3974318.5569	24.59
458	Black	32.00		431064.9034	3974310.6117	22.18
1597	Black	32.00		431058.5021	3974274.0414	31.67
1848	Black	32.00		431056.8368	3974261.0500	42.63
2012	Black	32.00		431063.3508	3974273.7582	28.57
2076	Black	32.00		431061.0676	3974269.1193	33.62
2224	Black	32.00		431060.4729	3974259.4877	41.99
2086	Black	32.00		431058.7157	3974268.7605	35.37

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
2110	Black	32.00		431060.9891	3974266.6039	35.70
3783	Black	32.00		431065.7994	3974273.2647	27.49
4181	Black	32.00		431085.5124	3974328.9494	33.34
4255	Black	32.00		431059.9147	3974309.3784	25.44
4357	Black	32.00		431064.9042	3974280.0877	22.86
389	Black	31.90		431057.1189	3974328.5250	40.74
688	Black	31.80		431107.8938	3974362.2954	71.51
504	Black	31.70		431097.6431	3974377.6591	83.39
6	Black	31.40		431007.0374	3974340.2779	86.67
718	Black	31.10		431096.6751	3974339.0849	45.83
1923	Black	31.00		431060.1314	3974278.1895	27.69
1999	Black	31.00		431059.6159	3974272.5452	31.94
2056	Black	31.00		431060.5942	3974270.8671	32.55
2247	Black	31.00		431062.7510	3974259.9352	40.50
2183	Black	31.00		431058.6645	3974264.4490	38.81
3841	Black	31.00		431067.2015	3974270.7371	28.88
3853	Black	31.00		431070.2306	3974270.7866	27.47
3984	Black	31.00		431107.8943	3974307.5693	28.91
4265	Black	31.00		431061.4359	3974304.8382	21.95
4287	Black	31.00		431056.9554	3974298.3703	24.63
22	Black	30.30		431042.4796	3974322.6367	47.30
1503	Black	30.00		431056.9119	3974279.7869	29.34
1344	Black	30.00		431045.4660	3974270.1591	44.22
1442	Black	30.00		431052.1489	3974260.0786	46.25
1757	Black	30.00		431057.2293	3974266.6211	37.97
1869	Black	30.00		431057.3924	3974259.8724	43.29
2013	Black	30.00		431063.0571	3974273.5219	28.94
2257	Black	30.00		431065.4653	3974259.6041	39.62
2130	Black	30.00		431062.6438	3974267.9821	33.63
2153	Black	30.00		431060.5141	3974265.1244	37.19
2157	Black	30.00		431060.2112	3974266.2424	36.45
4037	Black	30.00		431100.7816	3974324.0508	34.18
4327	Black	30.00		431057.6321	3974283.4770	26.85
4395	Black	30.00		431061.4598	3974280.1662	25.42
1328	Black	29.70		431047.6587	3974275.6013	39.40
846	Black	29.60		431029.4649	3974314.9142	55.38
468	Black	29.40		431072.9174	3974311.5810	17.90
502	Black	29.20		431101.7315	3974372.8638	79.63
732	Black	29.20		431091.8452	3974339.9506	45.30

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
1533	Black	29.00		431051.5632	3974275.0043	36.45
1424	Black	29.00		431051.5847	3974260.8666	46.01
1550	Black	29.00		431053.4698	3974273.8123	35.63
1641	Black	29.00		431056.7766	3974272.0462	34.29
1663	Black	29.00		431053.2545	3974269.5261	38.58
1774	Black	29.00		431053.6597	3974262.9243	43.10
1783	Black	29.00		431054.3920	3974262.7818	42.74
2060	Black	29.00		431061.4575	3974270.3879	32.38
2062	Black	29.00		431062.1874	3974270.6857	31.70
2124	Black	29.00		431063.8231	3974269.3529	31.83
2189	Black	29.00		431060.7374	3974264.2725	37.77
3692	Black	29.00		431065.6597	3974277.3735	24.31
3748	Black	29.00		431065.6161	3974274.8824	26.28
3769	Black	29.00		431068.8360	3974275.1984	24.21
3885	Black	29.00		431064.8491	3974269.0719	31.51
3955	Black	29.00		431071.6758	3974271.2497	26.48
4052	Black	29.00		431100.3378	3974324.4967	34.30
4158	Black	29.00		431089.2466	3974329.0910	34.14
4208	Black	29.00		431079.9633	3974332.0417	36.22
4307	Black	29.00		431053.4299	3974286.6259	29.51
4351	Black	29.00		431063.2961	3974281.5151	23.14
4388	Black	29.00		431058.5940	3974281.1745	27.17
830	Black	28.80		431049.8738	3974338.0653	52.72
646	Black	28.40		431114.4787	3974356.4494	69.01
671	Black	28.20		431104.0833	3974335.3634	45.53
789	Black	28.10		431078.0874	3974351.5143	55.76
1618	Black	28.00		431052.0774	3974271.7654	38.00
1718	Black	28.00		431056.2131	3974267.6803	37.83
2031	Black	28.00		431061.6619	3974272.3242	30.75
4062	Grey	28.00		431102.4291	3974331.0042	40.93
4087	Grey	28.00		431092.7533	3974320.8254	27.41
4226	Black	28.00		431068.8618	3974320.3325	27.53
4267	Black	28.00		431055.1005	3974303.2407	27.38
4385	Black	28.00		431059.0265	3974281.0573	26.87
716	Black	27.70		431094.8606	3974341.8730	47.93
398	Black	27.30		431063.5818	3974323.8321	33.20
758	Black	27.10		431086.3003	3974368.1509	72.46
1553	Black	27.00		431054.9180	3974275.2627	33.59
1559	Black	27.00		431057.2986	3974277.2604	30.49

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
1619	Black	27.00		431051.3157	3974271.2931	38.88
1686	Black	27.00		431056.1887	3974268.8474	36.99
1750	Black	27.00		431057.1593	3974267.0404	37.69
1763	Black	27.00		431055.7831	3974265.4848	39.77
1877	Black	27.00		431055.2634	3974258.1321	45.93
1888	Black	27.00		431057.9657	3974258.9219	43.77
1970	Black	27.00		431064.0026	3974274.8967	27.28
1980	Black	27.00		431061.8923	3974274.6930	28.82
2207	Black	27.00		431060.6743	3974262.6306	39.19
3822	Black	27.00		431070.1727	3974273.4397	25.10
3925	Black	27.00		431071.5013	3974260.5842	36.65
3935	Black	27.00		431074.4022	3974264.0803	32.55
3979	Black	27.00		431106.5252	3974277.5067	31.06
4025	Black	27.00		431110.0339	3974327.9006	42.94
4130	Black	27.00		431093.4081	3974332.4820	38.53
4192	Black	27.00		431082.2381	3974331.7105	35.87
4220	Black	27.00		431073.4204	3974324.5361	29.79
4302	Black	27.00		431051.3984	3974289.0465	30.82
401	Black	26.90		431064.5361	3974320.1633	29.62
414	Black	26.50		431063.6108	3974315.5916	26.61
428	Black	26.20		431066.8415	3974317.1982	25.87
1416	Black	26.00		431050.0576	3974261.2890	46.70
1427	Black	26.00		431050.2680	3974260.2374	47.34
1746	Black	26.00		431056.4149	3974266.8404	38.33
1771	Black	26.00		431053.8686	3974263.2259	42.73
1805	Black	26.00		431053.8448	3974259.4101	45.72
1919	Black	26.00		431059.6805	3974279.6755	27.13
2042	Black	26.00		431058.1366	3974271.2245	33.92
3708	Black	26.00		431065.3090	3974276.1877	25.45
4102	Grey	26.00		431097.9265	3974327.9253	36.05
4125	Black	26.00		431096.8403	3974334.3090	41.42
4186	Black	26.00		431084.0963	3974334.6876	38.92
4216	Black	26.00		431078.2791	3974325.5525	29.87
4346	Black	26.00		431061.6182	3974282.9003	23.70
4349	Black	26.00		431063.6256	3974281.6093	22.83
678	Black	25.60		431099.2990	3974339.3389	47.00
17	Black	25.50		431031.2402	3974329.2941	60.34
512	Black	25.50		431017.2575	3974316.7340	67.51
1387	Black	25.00		431043.0512	3974260.3017	52.34

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
1704	Black	25.00		431053.6449	3974266.1604	40.69
1708	Black	25.00		431054.5615	3974266.3180	39.95
1837	Black	25.00		431054.9755	3974261.6527	43.26
1964	Black	25.00		431062.2732	3974275.4877	27.98
1992	Black	25.00		431060.5402	3974272.6966	31.21
2084	Black	25.00		431057.9666	3974268.5232	36.04
2089	Black	25.00		431057.8478	3974267.1938	37.13
3710	Black	25.00		431065.2640	3974276.3181	25.38
3791	Black	25.00		431065.0708	3974273.7391	27.53
3804	Black	25.00		431066.5994	3974272.2786	27.87
3815	Black	25.00		431069.7482	3974274.2454	24.58
3848	Black	25.00		431070.1231	3974271.5092	26.85
3877	Black	25.00		431069.5545	3974269.2285	29.17
3890	Black	25.00		431067.7131	3974268.1439	30.93
3966	Black	25.00		431074.5103	3974268.1755	28.54
4034	Black	25.00		431103.0547	3974328.0410	38.76
4209	Grey	25.00		431080.5908	3974332.5007	36.66
4276	Black	25.00		431052.1270	3974308.0190	31.76
757	Black	24.90		431088.1952	3974361.6596	66.15
536	Black	24.50		431039.8175	3974249.2707	62.48
508	Black	24.40		430998.9886	3974336.3085	91.86
840	Black	24.10		431043.8387	3974318.2295	43.77
14	Black	24.00		431021.1786	3974326.5806	67.66
1370	Black	24.00		431049.5808	3974264.8913	44.44
1388	Black	24.00		431042.9014	3974260.5728	52.26
1536	Black	24.00		431055.1498	3974277.1192	32.30
1557	Black	24.00		431056.2850	3974276.8240	31.56
1732	Black	24.00		431054.6668	3974264.7586	41.05
1748	Black	24.00		431056.2647	3974267.1256	38.21
1820	Black	24.00		431056.8863	3974263.2597	40.82
1841	Black	24.00		431055.8617	3974260.4058	43.72
1924	Black	24.00		431059.2055	3974277.6424	28.76
2029	Black	24.00		431062.1524	3974272.2364	30.51
2041	Black	24.00		431058.0991	3974271.2441	33.93
2061	Black	24.00		431061.5937	3974270.0724	32.55
2126	Black	24.00		431063.4545	3974268.4589	32.78
2161	Black	24.00		431059.4600	3974267.0592	36.24
3838	Black	24.00		431067.0822	3974271.1019	28.62
4251	Black	24.00		431058.5526	3974311.8899	27.96

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
4339	Black	24.00		431060.9965	3974284.9221	23.20
4366	Black	24.00		431062.5560	3974281.3261	23.84
828	Black	23.90		431050.3697	3974344.9536	58.12
516	Black	23.80		431027.5705	3974303.8484	54.48
497	Black	23.70		431123.0000	3974362.0839	78.18
715	Black	23.50		431095.7656	3974341.9444	48.26
505	Black	23.40		431109.6143	3974387.1894	95.58
529	Black	23.30		431042.2708	3974258.6648	54.03
1331	Black	23.00		431047.3684	3974273.6070	40.71
1342	Black	23.00		431047.5657	3974269.8047	42.75
1345	Black	23.00		431041.3905	3974270.1393	47.61
1347	Black	23.00		431042.8608	3974267.2174	48.06
1395	Black	23.00		431048.0186	3974262.6470	47.13
1796	Black	23.00		431056.4955	3974264.4685	40.10
1819	Black	23.00		431056.9559	3974263.0791	40.92
1846	Black	23.00		431056.3139	3974260.8265	43.12
1861	Black	23.00		431058.6892	3974261.7961	40.97
1945	Black	23.00		431063.5664	3974278.7795	24.73
1969	Black	23.00		431063.9393	3974275.0321	27.21
1982	Black	23.00		431061.4572	3974274.7485	29.08
2208	Black	23.00		431061.0532	3974262.6653	38.96
2093	Black	23.00		431058.2134	3974268.4719	35.92
3727	Black	23.00		431065.5076	3974275.3560	25.97
3907	Black	23.00		431065.6247	3974265.4130	34.31
3963	Black	23.00		431072.4333	3974267.9847	29.29
4073	Black	23.00		431101.3508	3974333.2144	42.33
27	Black	22.80		431053.0329	3974321.6313	38.38
665	Black	22.70		431106.1162	3974346.3836	56.22
835	Black	22.60		431041.8058	3974336.2145	56.58
429	Black	22.40		431066.4562	3974317.2338	26.12
730	Black	22.20		431091.6836	3974336.5692	41.98
1317	Black	22.10		431049.3880	3974281.6988	35.06
1491	Black	22.00		431050.4020	3974277.6620	35.99
1527	Black	22.00		431056.7352	3974278.4775	30.22
1390	Black	22.00		431047.1317	3974263.4773	47.19
1399	Black	22.00		431051.0455	3974263.6619	44.29
1410	Black	22.00		431046.6204	3974259.2470	50.54
1668	Black	22.00		431052.6511	3974268.1564	39.96
1674	Black	22.00		431052.8403	3974267.8198	40.06

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
1702	Black	22.00		431052.2548	3974265.4550	42.16
1769	Black	22.00		431055.0255	3974263.8693	41.49
1822	Black	22.00		431056.2768	3974263.9611	40.64
1995	Black	22.00		431059.3566	3974273.3892	31.52
2155	Black	22.00		431060.0348	3974265.5805	37.09
3722	Black	22.00		431066.5927	3974275.9911	24.81
3973	Black	22.00		431100.7396	3974274.1231	29.05
3988	Black	22.00		431103.8494	3974311.2533	27.17
4004	Black	22.00		431099.2337	3974317.5242	28.03
4044	Grey	22.00		431093.8532	3974319.9813	27.12
4149	Black	22.00		431092.2923	3974331.8297	37.57
4196	Black	22.00		431082.2854	3974328.5890	32.75
4203	Black	22.00		431082.2831	3974323.7121	27.87
4390	Black	22.00		431057.1625	3974281.0247	28.47
411	Black	21.90		431064.0005	3974318.7614	28.80
826	Black	21.70		431060.3368	3974335.6524	45.06
662	Black	21.50		431104.6829	3974345.9633	55.23
503	Black	21.30		431098.8224	3974376.2933	82.29
473	Black	21.20		431075.8866	3974314.6884	19.64
507	Black	21.00		431056.2755	3974372.5605	80.74
1478	Black	21.00		431053.4722	3974255.8977	48.78
1565	Black	21.00		431055.1467	3974274.2564	34.04
1616	Black	21.00		431053.1705	3974271.9072	37.06
1651	Black	21.00		431056.7691	3974270.8064	35.17
1891	Black	21.00		431058.7909	3974259.3782	42.95
2053	Black	21.00		431059.8567	3974270.6476	33.20
2164	Black	21.00		431058.8779	3974266.5560	36.99
3674	Black	21.00		431064.9100	3974278.6297	23.89
3690	Black	21.00		431065.6235	3974277.7932	24.02
3750	Black	21.00		431066.4340	3974275.0245	25.68
3812	Black	21.00		431068.8849	3974273.7664	25.42
3821	Black	21.00		431070.1860	3974272.9850	25.50
3953	Black	21.00		431073.9690	3974271.1774	25.79
4000	Black	21.00		431100.9936	3974315.6393	27.80
4023	Black	21.00		431108.1838	3974328.8806	42.48
4113	Black	21.00		431091.6714	3974322.2175	28.27
4191	Black	21.00		431083.2986	3974330.8883	35.08
4200	Black	21.00		431082.4506	3974322.9415	27.11
4207	Grey	21.00		431077.9023	3974328.0490	32.39

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
4211	Black	21.00		431078.0211	3974333.1913	37.50
4225	Black	21.00		431070.2548	3974319.8923	26.52
4234	Black	21.00		431069.0322	3974332.8383	39.02
4247	Black	21.00		431052.5186	3974311.8847	33.09
4343	Black	21.00		431061.2388	3974283.8086	23.54
4376	Black	21.00		431059.5250	3974283.6928	25.08
687	Black	20.70		431109.4642	3974356.0879	66.43
19	Black	20.30		431039.5193	3974329.8934	54.02
667	Black	20.20		431114.0432	3974346.3602	60.10
1484	Black	20.00		431053.6222	3974254.7444	49.65
1617	Black	20.00		431052.2998	3974271.8644	37.76
1727	Black	20.00		431052.9419	3974263.9662	42.78
1821	Black	20.00		431056.3281	3974263.8306	40.71
1831	Black	20.00		431058.3058	3974264.4278	39.03
1834	Black	20.00		431057.1937	3974263.4556	40.48
1994	Black	20.00		431059.2850	3974273.4333	31.53
2016	Black	20.00		431063.6994	3974272.5793	29.28
2021	Black	20.00		431064.3866	3974271.2872	29.92
2085	Black	20.00		431057.8521	3974268.4361	36.18
2109	Black	20.00		431060.8226	3974267.3678	35.18
2125	Black	20.00		431063.6062	3974268.9918	32.25
2173	Black	20.00		431060.1105	3974265.2211	37.34
2174	Black	20.00		431060.3591	3974265.3825	37.06
2187	Black	20.00		431059.3860	3974264.7992	38.10
3706	Black	20.00		431065.0371	3974276.2420	25.58
3718	Black	20.00		431066.5740	3974277.2675	23.81
3721	Black	20.00		431066.7348	3974276.0621	24.67
3844	Black	20.00		431068.4425	3974270.3487	28.63
3914	Black	20.00		431069.1768	3974266.2761	32.03
3942	Black	20.00		431073.4851	3974271.9526	25.20
3998	Black	20.00		431102.7763	3974316.5896	29.74
4189	Black	20.00		431082.1970	3974333.5070	37.66
4201	Black	20.00		431080.5126	3974321.8213	25.99
4218	Black	20.00		431074.4362	3974325.1465	30.12
4379	Black	20.00		431058.7645	3974282.8267	26.17
432	Black	19.90		431068.5701	3974318.1962	25.80
672	Black	19.50		431103.0114	3974335.5433	45.16
1362	Black	19.00		431050.2498	3974266.7533	42.67
1418	Black	19.00		431048.7717	3974260.5487	48.11

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
1581	Black	19.00		431055.1310	3974273.1527	34.76
1583	Black	19.00		431055.3580	3974273.1286	34.61
1696	Black	19.00		431053.4993	3974267.6398	39.72
1775	Black	19.00		431053.4622	3974262.5488	43.51
1781	Black	19.00		431053.8519	3974262.2435	43.50
1790	Black	19.00		431054.9471	3974263.3492	41.95
1811	Black	19.00		431054.6834	3974260.9601	43.98
1889	Black	19.00		431057.7901	3974259.1451	43.68
1917	Black	19.00		431059.1535	3974279.0026	27.96
1951	Black	19.00		431061.3711	3974276.9506	27.58
2037	Black	19.00		431060.4469	3974271.7325	31.99
2082	Black	19.00		431059.9468	3974271.0581	32.83
2232	Black	19.00		431062.7702	3974262.5701	38.17
2135	Black	19.00		431063.5461	3974267.4657	33.57
3776	Black	19.00		431066.9111	3974274.0391	26.22
3785	Black	19.00		431065.6767	3974273.0200	27.76
3882	Black	19.00		431065.5013	3974268.4282	31.73
3900	Black	19.00		431066.3724	3974266.6283	32.89
3903	Black	19.00		431064.9083	3974266.6172	33.60
3975	Black	19.00		431100.8008	3974275.9177	27.77
4084	Grey	19.00		431092.3895	3974319.7570	26.28
4294	Black	19.00		431058.1760	3974294.5881	23.32
4295	Black	19.00		431057.0199	3974294.3025	24.49
4341	Black	19.00		431060.4255	3974284.9656	23.69
674	Black	18.90		431100.6857	3974337.3449	45.73
768	Black	18.90		431082.5089	3974349.4476	53.60
5	Black	18.80		431003.4538	3974328.2543	84.47
509	Black	18.70		431018.5843	3974318.6894	66.90
699	Black	18.70		431102.5455	3974350.1670	58.26
702	Black	18.70		431098.3667	3974351.9913	58.63
755	Black	18.40		431089.8521	3974353.9036	58.65
493	Black	18.10		431041.7008	3974206.7729	97.55
745	Black	18.00		431086.7011	3974346.3242	50.74
1531	Black	18.00		431053.7648	3974276.8578	33.58
1423	Black	18.00		431051.5043	3974262.7792	44.62
1539	Black	18.00		431058.3617	3974278.0005	29.19
1677	Black	18.00		431052.3420	3974267.0049	40.99
1692	Black	18.00		431054.7732	3974268.5444	38.18
1709	Black	18.00		431054.6612	3974267.0471	39.34

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
1766	Black	18.00		431055.7243	3974264.9747	40.20
1916	Black	18.00		431058.7389	3974280.1473	27.62
2039	Black	18.00		431060.1587	3974271.3928	32.44
2234	Black	18.00		431063.2077	3974262.7407	37.81
2250	Black	18.00		431061.3502	3974257.7074	43.12
2102	Black	18.00		431059.9631	3974267.8423	35.31
2104	Black	18.00		431060.5180	3974268.2298	34.66
3733	Black	18.00		431064.6570	3974275.5355	26.37
3758	Black	18.00		431067.5322	3974275.8412	24.38
3818	Black	18.00		431069.5801	3974273.3073	25.48
3837	Black	18.00		431066.5895	3974271.1030	28.87
3860	Black	18.00		431065.4701	3974270.8028	29.72
3862	Black	18.00		431065.0181	3974270.7836	29.98
3870	Black	18.00		431066.0142	3974269.4154	30.62
3982	Black	18.00		431105.6913	3974280.2304	28.83
4005	Black	18.00		431100.4459	3974318.0377	29.20
4049	Grey	18.00		431098.0172	3974324.1641	32.80
4079	Black	18.00		431099.3749	3974329.6660	38.27
4101	Black	18.00		431099.0174	3974327.1282	35.87
4274	Black	18.00		431050.9754	3974303.4295	31.41
406	Black	17.90		431059.9801	3974319.5196	31.96
766	Black	17.80		431080.8958	3974353.1813	57.33
680	Black	17.50		431098.7243	3974337.7813	45.34
1319	Black	17.50		431048.6586	3974279.3005	36.74
677	Black	17.30		431101.3200	3974339.0584	47.55
725	Black	17.20		431093.2976	3974348.1927	53.66
430	Black	17.10		431066.3812	3974319.1389	27.74
478	Black	17.10	p99	431030.7384	3974358.7422	80.80
706	Black	17.00		431097.7889	3974354.1536	60.54
809	Black	17.00		431070.3206	3974345.4494	50.83
1340	Black	17.00		431049.2404	3974270.0698	41.27
1389	Black	17.00		431046.8248	3974263.5386	47.37
1438	Black	17.00		431045.4958	3974257.4764	52.60
1454	Black	17.00		431046.5443	3974255.5517	53.32
1612	Black	17.00		431055.2331	3974272.0111	35.45
1719	Black	17.00		431055.8657	3974267.8385	37.95
1824	Black	17.00		431056.7589	3974264.1488	40.19
1928	Black	17.00		431062.1692	3974279.1444	25.52
1930	Black	17.00		431062.6160	3974279.4745	24.97

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
1978	Black	17.00		431062.7467	3974274.3529	28.50
2024	Black	17.00		431062.5781	3974271.4958	30.82
2052	Black	17.00		431059.7546	3974269.9931	33.76
2074	Black	17.00		431061.6500	3974269.1379	33.26
2094	Black	17.00		431058.0386	3974267.9729	36.41
2127	Black	17.00		431063.6916	3974268.1312	32.93
2186	Black	17.00		431059.4903	3974265.0033	37.87
3720	Black	17.00		431066.6985	3974276.2083	24.57
3856	Black	17.00		431065.5000	3974271.4718	29.14
3978	Black	17.00		431106.0955	3974276.7715	31.16
4029	Black	17.00		431105.3211	3974328.4277	40.38
4041	Black	17.00		431096.9889	3974318.9967	27.87
4091	Grey	17.00		431094.7775	3974323.0509	30.28
4129	Black	17.00		431093.4999	3974330.8990	37.06
4147	Black	17.00		431091.7873	3974328.7296	34.46
4222	Black	17.00		431072.5076	3974320.6761	26.39
4237	Black	17.00		431065.1963	3974327.2967	35.40
4261	Black	17.00		431060.0690	3974306.8527	24.05
4319	Black	17.00		431058.2309	3974285.7884	25.32
1	Black	16.70		430997.3209	3974333.8224	92.31
409	Black	16.70		431057.1101	3974317.7192	32.73
412	Black	16.70		431062.5027	3974317.6574	28.89
714	Black	16.70		431095.6538	3974342.4408	48.70
832	Black	16.40		431031.6320	3974340.2805	66.76
420	Black	16.30		431060.1794	3974312.2567	26.87
696	Black	16.30		431101.6881	3974361.9548	69.13
1519	Black	16.00		431052.6401	3974277.3933	34.23
1532	Black	16.00		431053.5218	3974276.7097	33.87
1337	Black	16.00		431044.5887	3974271.4186	44.23
1339	Black	16.00		431049.7920	3974271.0401	40.23
1349	Black	16.00		431044.7083	3974268.0647	46.08
1355	Black	16.00		431048.8714	3974267.9412	42.91
1547	Black	16.00		431054.5284	3974275.4899	33.76
1676	Black	16.00		431051.4764	3974267.2320	41.45
1712	Black	16.00		431054.8720	3974267.4091	38.94
1779	Black	16.00		431053.6344	3974261.1659	44.47
1808	Black	16.00		431054.1461	3974260.7071	44.51
1950	Black	16.00		431061.4158	3974276.8223	27.64
1962	Black	16.00		431061.5930	3974275.3418	28.56

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
1966	Black	16.00		431062.3383	3974275.6839	27.79
2005	Black	16.00		431062.4332	3974273.3036	29.50
2007	Black	16.00		431063.1282	3974273.3302	29.04
3846	Black	16.00		431069.3897	3974271.4175	27.25
3849	Black	16.00		431070.0132	3974271.1656	27.21
4012	Grey	16.00		431102.5002	3974320.5450	32.44
4058	Black	16.00		431102.6214	3974326.1848	36.98
4077	Black	16.00		431099.2842	3974332.9640	41.17
4081	Black	16.00		431099.6327	3974328.7218	37.56
4127	Black	16.00		431095.2606	3974331.8404	38.54
4165	Grey	16.00		431086.0928	3974325.9626	30.46
4244	Black	16.00		431045.3676	3974314.0367	40.42
4277	Black	16.00		431053.1025	3974309.0073	31.26
4333	Black	16.00		431059.8437	3974286.6671	23.49
592	Black	15.60		431055.8143	3974251.0001	51.67
423	Black	15.50		431064.1578	3974312.4602	23.98
823	Black	15.40		431067.4960	3974335.8787	42.39
1320	Black	15.40		431048.0560	3974277.6321	38.05
756	Black	15.10		431087.1908	3974359.5942	64.00
1494	Black	15.00		431047.3144	3974271.3437	42.03
1371	Black	15.00		431049.3079	3974265.5278	44.20
1588	Black	15.00		431056.4331	3974274.2072	33.09
1611	Black	15.00		431055.3091	3974272.4807	35.07
1632	Black	15.00		431054.7274	3974270.7028	36.70
1634	Black	15.00		431054.8223	3974271.4443	36.13
1675	Black	15.00		431051.6908	3974267.6299	41.02
1695	Black	15.00		431054.3760	3974268.4056	38.56
1723	Black	15.00		431052.2176	3974264.2147	43.08
1845	Black	15.00		431056.1725	3974260.9087	43.13
1983	Black	15.00		431060.9934	3974275.0696	29.17
1991	Black	15.00		431060.5954	3974273.5996	30.51
2035	Black	15.00		431060.3815	3974272.2131	31.67
2051	Black	15.00		431058.6677	3974269.1202	35.13
2055	Black	15.00		431060.2633	3974270.9332	32.72
2083	Black	15.00		431057.7047	3974270.3766	34.83
2159	Black	15.00		431060.3142	3974266.4944	36.18
3681	Black	15.00		431064.7211	3974277.2314	25.04
3701	Black	15.00		431064.4147	3974276.4916	25.80
3707	Black	15.00		431065.1744	3974276.0468	25.64

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
3711	Black	15.00		431065.5329	3974276.3906	25.15
3741	Black	15.00		431064.6267	3974274.2108	27.42
3760	Black	15.00		431067.2031	3974275.2017	25.10
3781	Black	15.00		431066.3896	3974273.2871	27.14
3792	Black	15.00		431065.0044	3974273.7962	27.52
3865	Black	15.00		431066.1266	3974270.0208	30.04
3946	Black	15.00		431070.8366	3974271.2386	26.81
4236	Black	15.00		431063.7907	3974325.0781	34.15
4345	Black	15.00		431061.4265	3974284.0835	23.24
4375	Black	15.00		431059.5885	3974283.3647	25.19
746	Black	14.90		431086.8964	3974348.8137	53.24
767	Black	14.90		431081.7469	3974351.3763	55.52
790	Black	14.80		431079.7003	3974351.8207	56.00
489	Black	14.70		431001.1878	3974324.0033	85.07
1327	Black	14.70		431044.8146	3974276.3193	41.53
684	Black	14.50		431106.2014	3974347.1343	56.94
591	Black	14.10		431055.3929	3974250.4132	52.39
1499	Black	14.00		431051.9326	3974278.5455	34.23
1353	Black	14.00		431046.9631	3974267.7922	44.47
1372	Black	14.00		431049.1570	3974265.2737	44.48
1404	Black	14.00		431049.7664	3974262.7459	45.83
1409	Black	14.00		431046.0137	3974259.0288	51.11
1444	Black	14.00		431051.7276	3974259.8956	46.66
1456	Black	14.00		431047.6306	3974255.4183	52.72
1589	Black	14.00		431056.4029	3974274.4142	32.98
1606	Black	14.00		431056.7297	3974273.0308	33.65
1610	Black	14.00		431055.5295	3974272.4629	34.92
1659	Black	14.00		431055.0964	3974268.9804	37.65
1672	Black	14.00		431052.9159	3974268.8368	39.30
1701	Black	14.00		431051.6072	3974265.5972	42.51
1737	Black	14.00		431055.0496	3974266.1846	39.72
1832	Black	14.00		431057.4413	3974263.6016	40.21
1874	Black	14.00		431056.9134	3974259.2530	44.07
1967	Black	14.00		431062.3418	3974275.8992	27.64
1984	Black	14.00		431060.0923	3974274.6911	30.07
1985	Black	14.00		431059.9325	3974274.6883	30.19
1988	Black	14.00		431059.3039	3974275.4311	30.13
2001	Black	14.00		431061.6334	3974273.8992	29.58
2046	Black	14.00		431058.9450	3974271.0549	33.50

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
2065	Black	14.00		431064.0181	3974272.0277	29.53
2144	Black	14.00		431061.9899	3974265.5957	35.98
2197	Black	14.00		431058.7762	3974264.6027	38.62
3673	Black	14.00		431064.7270	3974279.2837	23.55
3698	Black	14.00		431065.0872	3974276.6374	25.25
3705	Black	14.00		431064.9193	3974276.1745	25.71
3717	Black	14.00		431066.0036	3974277.1442	24.27
3732	Black	14.00		431064.3995	3974275.1472	26.83
3743	Black	14.00		431065.4998	3974274.3713	26.76
3746	Black	14.00		431065.6263	3974274.6761	26.44
3749	Black	14.00		431066.2293	3974274.9842	25.84
3795	Black	14.00		431064.8801	3974273.8655	27.54
3826	Black	14.00		431070.1953	3974272.0417	26.34
4002	Grey	14.00		431099.3312	3974315.4722	26.54
4003	Black	14.00		431099.0236	3974316.0033	26.73
4086	Black	14.00		431093.2143	3974321.1219	27.87
4150	Black	14.00		431094.0443	3974335.2451	41.35
4256	Black	14.00		431060.4286	3974309.0417	24.83
4270	Black	14.00		431056.8159	3974302.0734	25.42
4278	Black	14.00		431052.8453	3974310.0933	31.96
4282	Black	14.00		431049.4259	3974296.7200	32.05
4293	Black	14.00		431058.1586	3974295.8478	23.30
4300	Black	14.00		431054.6734	3974293.8598	26.86
4337	Black	14.00		431060.7858	3974287.7205	22.22
4342	Black	14.00		431060.2006	3974284.1450	24.27
4350	Black	14.00		431063.3352	3974281.6690	23.02
4353	Black	14.00		431064.3375	3974280.3840	23.08
4399	Black	14.00		431065.0457	3974279.2690	23.33
659	Black	13.80		431103.7701	3974341.9344	51.20
798	Black	13.80		431072.7599	3974342.4178	47.37
519	Black	13.60		431036.3931	3974273.9811	50.10
654	Black	13.60		431109.9061	3974339.6848	52.25
729	Black	13.60		431092.3757	3974336.7817	42.36
785	Black	13.60		431079.3416	3974348.3271	52.52
806	Black	13.40		431070.2955	3974344.0988	49.52
456	Black	13.30		431067.1550	3974311.4215	21.14
469	Black	13.30		431073.3413	3974312.6711	18.68
701	Black	13.30		431099.5131	3974352.3156	59.28
842	Black	13.30		431037.8760	3974312.6266	46.70

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
437	Black	13.20		431070.7343	3974317.9095	24.53
506	Black	13.20		431085.1958	3974384.1583	88.38
816	Black	13.20		431068.6841	3974346.7142	52.44
24	Black	13.10		431048.3402	3974321.6592	41.99
635	Black	13.00		431120.7244	3974336.8616	56.77
1493	Black	13.00		431050.9102	3974274.5351	37.25
1379	Black	13.00		431046.1138	3974264.2816	47.39
1440	Black	13.00		431050.3749	3974259.2294	48.04
1472	Black	13.00		431050.6407	3974255.9641	50.41
1544	Black	13.00		431054.1549	3974275.3713	34.13
1604	Black	13.00		431057.1252	3974273.3756	33.13
1685	Black	13.00		431057.0837	3974268.3082	36.78
1713	Black	13.00		431055.1806	3974267.5084	38.65
1722	Black	13.00		431053.5448	3974265.6642	41.12
1726	Black	13.00		431052.9203	3974263.3899	43.23
1740	Black	13.00		431055.5382	3974266.1856	39.40
1743	Black	13.00		431056.2048	3974266.7712	38.52
1745	Black	13.00		431056.1438	3974266.5029	38.76
1857	Black	13.00		431058.5731	3974263.2973	39.80
1929	Black	13.00		431062.3907	3974279.5545	25.09
1942	Black	13.00		431064.2829	3974278.2395	24.60
1959	Black	13.00		431061.1312	3974276.0667	28.37
1963	Black	13.00		431062.0555	3974275.4669	28.15
2032	Black	13.00		431061.5230	3974272.5232	30.69
2213	Black	13.00		431059.5390	3974261.7885	40.51
2097	Black	13.00		431059.4386	3974267.5424	35.87
2145	Black	13.00		431061.8454	3974265.6820	35.99
2195	Black	13.00		431063.6342	3974264.4191	36.14
2203	Black	13.00		431059.0759	3974262.8006	39.92
3693	Black	13.00		431065.2025	3974277.3123	24.66
3704	Black	13.00		431064.5218	3974275.7665	26.28
3715	Black	13.00		431066.1694	3974276.7534	24.47
3757	Black	13.00		431067.4053	3974275.9910	24.33
3766	Black	13.00		431068.1234	3974275.2198	24.57
3793	Black	13.00		431064.9714	3974273.6150	27.68
3855	Black	13.00		431064.9161	3974271.4964	29.44
3867	Black	13.00		431065.4244	3974269.9025	30.51
3868	Black	13.00		431065.3789	3974269.6661	30.73
3871	Black	13.00		431067.0434	3974269.5858	29.96

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
3886	Black	13.00		431064.4074	3974269.3476	31.52
3901	Black	13.00		431065.8150	3974266.6838	33.10
3941	Black	13.00		431073.7629	3974271.8124	25.24
4085	Black	13.00		431091.8889	3974319.6568	25.99
4239	Black	13.00		431056.0094	3974313.7256	31.10
4258	Black	13.00		431060.8436	3974309.0799	24.50
4328	Black	13.00		431056.0033	3974282.9517	28.54
4330	Black	13.00		431055.1680	3974282.1915	29.63
4374	Black	13.00		431060.0381	3974283.5316	24.71
4378	Black	13.00		431059.0641	3974282.9223	25.86
4394	Black	13.00		431060.8906	3974280.2198	25.84
28	Black	12.70		431053.1278	3974320.4138	37.50
760	Black	12.70		431079.9112	3974369.0476	73.21
733	Black	12.50		431090.8730	3974340.2373	45.37
796	Black	12.40		431070.2317	3974358.7850	63.93
405	Black	12.30		431062.9031	3974319.3250	29.92
443	Black	12.10		431071.9079	3974316.3365	22.60
483	Black	12.00	p104	431018.0687	3974340.4708	77.52
634	Black	12.00		431124.2735	3974340.8528	62.11
829	Black	12.00		431054.5831	3974338.2141	50.17
1477	Black	12.00		431052.4527	3974255.9695	49.32
1492	Black	12.00		431049.8238	3974278.4811	36.09
1495	Black	12.00		431046.8001	3974274.1236	40.91
1333	Black	12.00		431041.2175	3974276.3480	44.72
1341	Black	12.00		431050.4602	3974269.9710	40.38
1356	Black	12.00		431049.1911	3974267.8658	42.72
1357	Black	12.00		431049.8614	3974267.8294	42.24
1398	Black	12.00		431050.8107	3974263.1641	44.81
1420	Black	12.00		431050.4859	3974261.4373	46.30
1459	Black	12.00		431051.0529	3974257.0794	49.28
1622	Black	12.00		431052.1216	3974270.1231	39.02
1624	Black	12.00		431053.7374	3974270.9740	37.25
1644	Black	12.00		431057.5917	3974270.7193	34.66
1654	Black	12.00		431055.2959	3974270.0258	36.77
1710	Black	12.00		431054.3703	3974267.4712	39.24
1721	Black	12.00		431056.2818	3974268.0877	37.48
1744	Black	12.00		431055.9710	3974266.5598	38.83
1761	Black	12.00		431056.1607	3974265.5488	39.48
1799	Black	12.00		431056.0563	3974263.2695	41.32

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
1859	Black	12.00		431058.7709	3974262.4412	40.39
1860	Black	12.00		431058.8669	3974262.4455	40.33
1893	Black	12.00		431059.8081	3974260.2524	41.67
2000	Black	12.00		431061.4812	3974273.1281	30.26
2002	Black	12.00		431061.8063	3974273.8217	29.52
2008	Black	12.00		431063.2236	3974273.1958	29.09
2020	Black	12.00		431064.0542	3974271.5417	29.90
2022	Black	12.00		431062.9072	3974271.4186	30.68
2068	Black	12.00		431063.7287	3974270.3263	31.08
2072	Black	12.00		431061.7028	3974269.2091	33.17
2077	Black	12.00		431060.5896	3974269.1920	33.86
2211	Black	12.00		431058.9483	3974262.1958	40.49
2107	Black	12.00		431060.3865	3974266.7332	35.95
2116	Black	12.00		431062.1496	3974268.9520	33.12
2171	Black	12.00		431059.5404	3974265.7529	37.24
2201	Black	12.00		431060.3358	3974263.5868	38.57
3678	Black	12.00		431064.4358	3974278.0034	24.67
3686	Black	12.00		431066.3100	3974277.9488	23.45
3726	Black	12.00		431065.9121	3974275.6519	25.49
3754	Black	12.00		431067.5314	3974276.7553	23.64
3765	Black	12.00		431067.7007	3974274.8996	25.07
3786	Black	12.00		431065.6869	3974273.2199	27.59
3808	Black	12.00		431067.6156	3974272.0700	27.52
3817	Black	12.00		431069.6494	3974273.4890	25.29
3832	Black	12.00		431067.7736	3974272.0177	27.49
3950	Black	12.00		431071.0133	3974270.4401	27.48
3971	Black	12.00		431094.6809	3974270.0899	28.96
3980	Black	12.00		431106.6873	3974275.6308	32.33
4001	Black	12.00		431100.2909	3974315.4485	27.18
4028	Black	12.00		431105.3844	3974329.3725	41.18
4074	Black	12.00		431102.1191	3974332.2158	41.82
4116	Black	12.00		431092.5854	3974322.7858	29.14
4173	Black	12.00		431086.7305	3974321.8375	26.51
4219	Black	12.00		431073.8892	3974325.1086	30.22
4240	Black	12.00		431055.8693	3974312.9620	30.78
4271	Black	12.00		431054.0727	3974302.4667	28.18
4288	Black	12.00		431057.3529	3974299.4054	24.37
4334	Black	12.00		431060.3019	3974286.7338	23.04
4363	Black	12.00		431063.7090	3974280.6036	23.40

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
4392	Black	12.00		431059.8183	3974280.4850	26.54
521	Black	11.90		431030.9684	3974259.7229	62.09
726	Black	11.90		431093.6328	3974346.9775	52.55
487	Black	11.80		431011.2919	3974324.6886	75.86
647	Black	11.80		431113.8279	3974353.0728	65.74
472	Black	11.50		431075.2084	3974314.5992	19.76
515	Black	11.50		431017.8959	3974311.1850	65.39
753	Black	11.50		431091.9410	3974360.1785	65.17
440	Black	11.40		431072.3608	3974317.5532	23.53
482	Black	11.40	p103	431019.6741	3974344.3501	78.55
434	Black	11.30		431068.5699	3974319.4110	26.85
513	Black	11.30		431024.0684	3974316.2447	60.91
645	Black	11.20		431115.7344	3974356.3473	69.53
795	Black	11.20		431069.5687	3974359.3676	64.62
466	Black	11.00		431070.8098	3974311.5548	18.97
752	Black	11.00		431094.0483	3974350.8615	56.43
821	Black	11.00		431067.3839	3974337.4991	43.96
1515	Black	11.00		431052.0385	3974278.3837	34.22
1530	Black	11.00		431055.1684	3974277.7465	31.92
1318	Black	11.00		431047.0191	3974281.0260	37.50
1384	Black	11.00		431044.3338	3974261.8317	50.36
1447	Black	11.00		431051.0815	3974258.9591	47.79
1572	Black	11.00		431057.3788	3974276.3332	31.00
1578	Black	11.00		431053.0914	3974272.8823	36.50
1609	Black	11.00		431055.7174	3974272.6530	34.66
1613	Black	11.00		431054.8035	3974272.0775	35.72
1636	Black	11.00		431055.8270	3974271.3022	35.49
1665	Black	11.00		431052.4693	3974269.0732	39.47
1706	Black	11.00		431054.2871	3974266.1413	40.26
1720	Black	11.00		431055.9881	3974267.9999	37.74
1751	Black	11.00		431056.8355	3974267.6930	37.41
1829	Black	11.00		431057.5350	3974265.3677	38.75
1839	Black	11.00		431054.3821	3974259.2654	45.52
1858	Black	11.00		431058.6908	3974263.2317	39.78
1913	Black	11.00		431059.0292	3974280.2015	27.35
1933	Black	11.00		431062.6208	3974278.6050	25.54
1936	Black	11.00		431062.6797	3974277.2995	26.40
1968	Black	11.00		431063.1911	3974275.9337	27.03
1977	Black	11.00		431063.4296	3974273.9081	28.40

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
2010	Black	11.00		431063.6611	3974273.3066	28.73
2034	Black	11.00		431060.1519	3974272.7450	31.43
2226	Black	11.00		431061.0561	3974259.7688	41.45
2088	Black	11.00		431058.1528	3974267.6840	36.56
2167	Black	11.00		431059.1193	3974265.9479	37.33
2190	Black	11.00		431060.7368	3974264.3622	37.70
3684	Black	11.00		431066.1964	3974278.0543	23.45
3737	Black	11.00		431064.5421	3974274.5894	27.17
3745	Black	11.00		431065.7874	3974274.6344	26.38
3752	Black	11.00		431066.7371	3974274.2236	26.17
3770	Black	11.00		431068.1382	3974275.0978	24.66
3773	Black	11.00		431068.1948	3974274.4897	25.15
3780	Black	11.00		431066.4188	3974273.4343	27.00
3790	Black	11.00		431065.2700	3974273.9073	27.27
3806	Black	11.00		431067.1112	3974272.0874	27.76
3809	Black	11.00		431067.9003	3974273.1099	26.48
3824	Black	11.00		431069.3772	3974272.2443	26.52
3873	Black	11.00		431068.2075	3974269.3904	29.60
3887	Black	11.00		431064.5133	3974269.6748	31.19
3897	Black	11.00		431067.8762	3974266.4359	32.40
3908	Black	11.00		431065.3737	3974264.8951	34.89
3997	Black	11.00		431103.2777	3974317.3463	30.63
4033	Grey	11.00		431104.0507	3974327.2412	38.67
4109	Black	11.00		431096.3160	3974327.1732	34.66
4153	Black	11.00		431089.9776	3974334.7606	39.83
4182	Black	11.00		431085.6249	3974328.9798	33.39
4193	Black	11.00		431081.5625	3974333.8901	38.04
4194	Black	11.00		431081.4087	3974331.1452	35.29
4249	Black	11.00		431055.2315	3974310.7310	30.16
4268	Black	11.00		431056.4237	3974303.3717	26.14
4275	Black	11.00		431053.4240	3974306.4129	29.96
4367	Black	11.00		431061.8393	3974280.7270	24.78
4381	Black	11.00		431059.0816	3974282.6549	25.98
669	Black	10.80		431104.0077	3974336.6854	46.64
721	Black	10.80		431094.1839	3974360.9670	66.35
712	Black	10.50		431096.4135	3974344.8696	51.25
770	Black	10.50		431079.8958	3974343.5747	47.75
827	Black	10.50		431055.3086	3974345.8508	56.42
814	Black	10.30		431066.4792	3974355.0114	61.03

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
792	Black	10.20		431074.9819	3974359.7252	64.20
7	Black	10.00		431008.2338	3974337.4222	84.20
1506	Black	10.00		431053.7925	3974278.5092	32.66
1522	Black	10.00		431053.3211	3974277.2576	33.73
1538	Black	10.00		431055.4392	3974276.9027	32.19
1556	Black	10.00		431056.1348	3974276.7075	31.75
1558	Black	10.00		431056.7712	3974277.1595	30.97
1626	Black	10.00		431054.2652	3974271.0911	36.78
1639	Black	10.00		431055.7321	3974272.0556	35.05
1655	Black	10.00		431055.7441	3974270.5807	36.06
1664	Black	10.00		431052.2243	3974269.4985	39.36
1730	Black	10.00		431053.6421	3974264.3844	42.00
1768	Black	10.00		431055.2516	3974264.2649	41.05
1801	Black	10.00		431053.1236	3974259.4716	46.12
1838	Black	10.00		431054.5693	3974259.5638	45.17
1840	Black	10.00		431054.8911	3974259.6402	44.91
1875	Black	10.00		431056.8543	3974258.8137	44.47
1907	Black	10.00		431059.9669	3974255.0757	46.10
1935	Black	10.00		431062.8747	3974277.5747	26.07
1944	Black	10.00		431064.3910	3974278.7626	24.16
1953	Black	10.00		431060.2905	3974276.6088	28.61
1956	Black	10.00		431058.9343	3974277.4551	29.09
1974	Black	10.00		431063.8132	3974274.4468	27.74
2040	Black	10.00		431058.7963	3974271.7766	33.07
2219	Black	10.00		431059.9488	3974261.2973	40.70
2225	Black	10.00		431060.6615	3974259.6415	41.76
2246	Black	10.00		431063.0690	3974260.2546	40.07
2258	Black	10.00		431066.0887	3974259.8585	39.14
2098	Black	10.00		431059.1535	3974267.8401	35.81
2108	Black	10.00		431060.3383	3974267.3949	35.44
2113	Black	10.00		431061.6853	3974268.2347	33.97
2121	Black	10.00		431062.5849	3974268.8516	32.95
2163	Black	10.00		431059.1768	3974266.7917	36.62
2172	Black	10.00		431059.7019	3974265.5468	37.31
2188	Black	10.00		431059.6032	3974264.6219	38.12
3679	Black	10.00		431064.1668	3974277.9118	24.92
3691	Black	10.00		431065.8045	3974277.6368	24.02
3697	Black	10.00		431065.3328	3974276.6948	25.04
3725	Black	10.00		431066.1819	3974276.0829	24.99

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
3730	Black	10.00		431065.1070	3974275.5587	26.06
3747	Black	10.00		431065.6275	3974274.8333	26.32
3775	Black	10.00		431067.0884	3974273.6671	26.43
3814	Black	10.00		431069.2114	3974274.1795	24.90
3857	Black	10.00		431065.4508	3974271.3312	29.29
3937	Black	10.00		431075.6209	3974271.8710	24.68
3938	Black	10.00		431075.0834	3974272.2564	24.44
3947	Black	10.00		431070.6351	3974270.8663	27.23
4050	Grey	10.00		431101.9098	3974321.3232	32.66
4054	Grey	10.00		431100.8473	3974325.7852	35.66
4056	Black	10.00		431101.7410	3974325.3714	35.81
4097	Black	10.00		431096.1391	3974323.1911	31.03
4099	Grey	10.00		431095.8598	3974323.4860	31.16
4117	Black	10.00		431092.8913	3974323.9083	30.29
4168	Black	10.00		431088.0810	3974323.2956	28.23
4264	Black	10.00		431062.2021	3974307.2517	22.38
4279	Black	10.00		431042.7238	3974302.3530	39.28
4280	Black	10.00		431051.7787	3974297.9763	29.76
4284	Black	10.00		431051.4485	3974295.4060	30.02
4289	Black	10.00		431057.8192	3974297.9127	23.73
4290	Black	10.00		431055.6893	3974297.5749	25.83
4303	Black	10.00		431051.6622	3974288.3857	30.72
4312	Black	10.00		431054.6774	3974285.8313	28.60
4380	Black	10.00		431058.6230	3974282.9617	26.23
447	Black	9.90		431073.1130	3974314.5162	20.45
395	Black	9.80		431065.7673	3974331.2634	38.73
788	Black	9.80		431078.3928	3974350.2189	54.45
399	Black	9.70		431064.1279	3974323.5502	32.67
20	Black	9.60		431032.0698	3974329.5779	59.81
664	Black	9.60		431104.4126	3974347.3313	56.36
841	Black	9.60		431036.2861	3974317.1122	49.93
9	Black	9.50		431011.5814	3974331.5088	78.45
457	Black	9.50		431065.3554	3974311.3951	22.38
679	Black	9.50		431099.3687	3974339.1578	46.86
689	Black	9.50		431106.5123	3974365.5144	74.03
484	Black	9.40	p105	431012.6231	3974339.8915	81.72
759	Black	9.20		431084.9378	3974368.5263	72.76
455	Black	9.10		431067.1819	3974312.8232	22.18
460	Black	9.10		431071.8031	3974313.2470	19.90

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
847	Black	9.10		431035.3898	3974315.6251	50.14
453	Black	9.00		431068.7511	3974312.9434	21.30
1501	Black	9.00		431053.1087	3974279.9226	32.52
1504	Black	9.00		431055.4468	3974280.2134	30.35
1513	Black	9.00		431057.6601	3974278.8444	29.25
1528	Black	9.00		431054.6448	3974277.8310	32.31
1363	Black	9.00		431050.6837	3974266.5713	42.48
1369	Black	9.00		431049.7280	3974265.2623	44.08
1540	Black	9.00		431057.2805	3974277.9090	30.11
1554	Black	9.00		431055.6770	3974276.0504	32.51
1561	Black	9.00		431056.3404	3974276.1598	31.92
1573	Black	9.00		431057.1096	3974276.4216	31.15
1575	Black	9.00		431051.4896	3974273.3222	37.50
1590	Black	9.00		431057.1064	3974274.5501	32.36
1593	Black	9.00		431057.4283	3974275.2902	31.63
1600	Black	9.00		431057.9460	3974273.6767	32.32
1603	Black	9.00		431057.1783	3974273.0524	33.31
1629	Black	9.00		431054.1945	3974270.6076	37.16
1637	Black	9.00		431055.9571	3974271.6098	35.19
1643	Black	9.00		431056.5637	3974271.3950	34.90
1650	Black	9.00		431056.9349	3974270.0631	35.59
1652	Black	9.00		431055.4660	3974269.4483	37.05
1690	Black	9.00		431057.2709	3974269.6451	35.67
1742	Black	9.00		431055.8345	3974266.4051	39.04
1754	Black	9.00		431057.4484	3974267.2544	37.34
1770	Black	9.00		431054.8621	3974264.2073	41.34
1890	Black	9.00		431058.4656	3974259.4357	43.07
1921	Black	9.00		431058.8795	3974279.4601	27.90
1939	Black	9.00		431063.9382	3974278.3433	24.77
1948	Black	9.00		431062.7255	3974276.5873	26.87
1954	Black	9.00		431060.0916	3974276.5720	28.78
1958	Black	9.00		431059.7959	3974276.1856	29.26
1993	Black	9.00		431059.2320	3974273.3807	31.61
2030	Black	9.00		431062.1727	3974271.8864	30.76
2099	Black	9.00		431059.7798	3974267.4893	35.70
3677	Black	9.00		431064.7046	3974278.0548	24.45
3685	Black	9.00		431066.0648	3974277.9459	23.62
3714	Black	9.00		431065.9764	3974276.4277	24.84
3724	Black	9.00		431066.3971	3974275.9237	24.98

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
3729	Black	9.00		431065.4389	3974275.2857	26.07
3755	Black	9.00		431067.6316	3974276.6896	23.63
3761	Black	9.00		431066.4389	3974275.2045	25.53
3819	Black	9.00		431069.1205	3974272.9509	26.02
3864	Black	9.00		431065.4727	3974270.4110	30.05
3878	Black	9.00		431068.9731	3974268.8801	29.72
3949	Black	9.00		431070.9596	3974270.3656	27.57
3956	Black	9.00		431071.9517	3974270.9459	26.66
3991	Black	9.00		431104.7358	3974313.9629	29.49
4017	Black	9.00		431106.1824	3974322.3428	36.23
4021	Black	9.00		431107.1641	3974325.8260	39.48
4059	Grey	9.00		431072.4475	3974272.7026	24.84
4060	Grey	9.00		431102.4733	3974328.4789	38.81
4092	Grey	9.00		431094.7544	3974323.0064	30.23
4106	Black	9.00		431098.1081	3974332.5883	40.33
4124	Black	9.00		431097.0549	3974331.9711	39.34
4128	Grey	9.00		431094.6436	3974330.3945	36.97
4161	Black	9.00		431087.0981	3974328.0622	32.70
4180	Black	9.00		431084.6115	3974328.3341	32.63
4185	Black	9.00		431087.2953	3974334.0681	38.66
4197	Black	9.00		431082.4362	3974325.7495	29.91
4199	Black	9.00		431083.2879	3974323.9610	28.17
4245	Black	9.00		431041.5634	3974317.2621	45.28
4250	Black	9.00		431056.7157	3974311.0959	29.06
4273	Black	9.00		431054.7749	3974301.3101	27.24
4298	Black	9.00		431056.6271	3974293.0834	24.99
4314	Black	9.00		431055.6084	3974288.7772	26.80
4364	Black	9.00		431063.5036	3974280.3954	23.69
4365	Black	9.00		431063.0617	3974281.4413	23.37
4368	Black	9.00		431062.4223	3974280.7913	24.28
4373	Black	9.00		431060.2450	3974282.2964	25.18
587	Black	8.80		431052.7309	3974250.2782	53.87
32	Black	8.70		431057.4699	3974323.9891	36.98
1338	Black	8.70		431048.6095	3974273.2670	39.87
26	Black	8.60		431044.1431	3974324.7500	47.20
31	Black	8.60		431048.7022	3974330.2010	47.47
747	Black	8.50		431090.7362	3974343.6375	48.68
825	Black	8.50		431057.5690	3974348.6066	57.91
408	Black	8.40		431058.2621	3974317.3227	31.61

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
763	Black	8.40		431082.2570	3974361.0521	65.20
734	Black	8.30		431090.4836	3974341.0943	46.13
13	Black	8.20		431030.3813	3974329.2247	61.02
683	Black	8.20		431100.4305	3974343.5704	51.35
720	Black	8.10		431096.5422	3974360.4064	66.29
1509	Black	8.00		431057.3003	3974279.1141	29.39
1510	Black	8.00		431057.2169	3974278.9338	29.56
1324	Black	8.00		431047.4027	3974277.4951	38.69
1364	Black	8.00		431050.0446	3974266.6311	42.91
1555	Black	8.00		431055.6865	3974276.0595	32.50
1560	Black	8.00		431057.4335	3974276.9804	30.55
1576	Black	8.00		431051.5370	3974272.7364	37.81
1584	Black	8.00		431055.5076	3974273.5625	34.21
1591	Black	8.00		431057.6207	3974274.5812	31.95
1605	Black	8.00		431057.1090	3974273.1310	33.31
1608	Black	8.00		431056.1471	3974272.8649	34.19
1630	Black	8.00		431054.1443	3974270.2998	37.41
1635	Black	8.00		431054.5722	3974271.7023	36.14
1640	Black	8.00		431056.1806	3974272.2492	34.59
1645	Black	8.00		431057.6330	3974270.9807	34.44
1656	Black	8.00		431054.7177	3974269.6287	37.46
1669	Black	8.00		431053.2032	3974268.4711	39.35
1693	Black	8.00		431054.9467	3974268.5387	38.07
1694	Black	8.00		431054.2908	3974268.7778	38.36
1703	Black	8.00		431053.6034	3974266.5885	40.40
1735	Black	8.00		431054.4985	3974265.9441	40.27
1738	Black	8.00		431055.0346	3974266.5909	39.43
1739	Black	8.00		431055.1553	3974266.1349	39.69
1807	Black	8.00		431053.6156	3974260.8979	44.69
1814	Black	8.00		431055.8257	3974262.6584	41.94
1827	Black	8.00		431057.3598	3974264.8328	39.28
1835	Black	8.00		431056.3677	3974262.2264	41.96
1894	Black	8.00		431059.7349	3974260.1896	41.76
1943	Black	8.00		431064.3554	3974278.6457	24.26
1947	Black	8.00		431063.5791	3974276.4944	26.35
1997	Black	8.00		431058.8502	3974272.9048	32.22
1998	Black	8.00		431059.0433	3974272.6985	32.23
2036	Black	8.00		431060.6548	3974272.0748	31.60
2206	Black	8.00		431060.4576	3974263.6351	38.46

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
2237	Black	8.00		431064.5754	3974264.0014	36.05
2158	Black	8.00		431060.1197	3974266.0581	36.65
2175	Black	8.00		431060.6065	3974264.9545	37.28
2176	Black	8.00		431060.8751	3974265.0676	37.03
2196	Black	8.00		431063.6500	3974264.8295	35.77
3728	Black	8.00		431065.5241	3974275.2905	26.02
3734	Black	8.00		431064.5214	3974275.4899	26.49
3735	Black	8.00		431064.6132	3974275.2972	26.58
3740	Black	8.00		431065.0316	3974274.1061	27.26
3742	Black	8.00		431064.5535	3974274.1620	27.50
3759	Black	8.00		431067.2485	3974275.4630	24.85
3762	Black	8.00		431067.4485	3974275.2534	24.91
3771	Black	8.00		431068.2311	3974274.8532	24.82
3777	Black	8.00		431066.5697	3974273.5263	26.84
3778	Black	8.00		431066.7470	3974273.2924	26.93
3784	Black	8.00		431065.7440	3974273.3155	27.48
3800	Black	8.00		431065.2736	3974272.5080	28.41
3803	Black	8.00		431066.5821	3974272.5768	27.63
3807	Black	8.00		431067.4613	3974272.0879	27.58
3813	Black	8.00		431068.6650	3974274.1936	25.16
3854	Black	8.00		431069.5495	3974271.0596	27.51
3875	Black	8.00		431070.4998	3974270.4088	27.70
3876	Black	8.00		431069.9700	3974269.2767	28.95
3893	Black	8.00		431069.7069	3974267.6087	30.59
3924	Black	8.00		431071.1758	3974261.0247	36.32
3930	Black	8.00		431071.0129	3974258.8479	38.45
3932	Black	8.00		431072.6589	3974259.7921	37.12
3989	Black	8.00		431104.3201	3974312.0641	28.02
4011	Black	8.00		431102.9473	3974319.2000	31.73
4066	Black	8.00		431101.6830	3974327.1310	37.25
4096	Black	8.00		431096.0384	3974323.0277	30.84
4144	Black	8.00		431089.9847	3974325.4452	30.80
4171	Grey	8.00		431086.9001	3974321.1322	25.86
4184	Grey	8.00		431084.7176	3974331.1530	35.45
4188	Black	8.00		431083.3812	3974333.2582	37.45
4206	Grey	8.00		431079.4582	3974328.7057	32.91
4248	Black	8.00		431052.6584	3974311.5758	32.81
4259	Black	8.00		431061.2878	3974308.8032	23.97
4269	Black	8.00		431056.9285	3974302.6020	25.44

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
4272	Black	8.00		431053.5980	3974303.0715	28.78
4291	Black	8.00		431053.3314	3974298.4155	28.25
4292	Black	8.00		431057.3832	3974295.8540	24.08
4324	Black	8.00		431058.4902	3974283.7769	25.95
4389	Black	8.00		431057.7022	3974281.6542	27.68
4393	Black	8.00		431060.8591	3974281.0878	25.35
488	Black	7.90		431006.0768	3974325.0470	80.84
394	Black	7.80		431065.8969	3974330.3653	37.86
471	Black	7.70		431073.7518	3974313.5362	19.29
787	Black	7.70		431078.3553	3974348.5795	52.82
416	Black	7.60		431062.9504	3974314.2199	26.08
804	Black	7.60		431071.5172	3974336.7660	42.10
16	Black	7.50		431023.4977	3974327.2418	65.92
845	Black	7.50		431039.1271	3974309.5924	44.51
682	Black	7.40		431102.0672	3974343.5186	51.93
803	Black	7.40		431072.6674	3974337.2599	42.33
18	Black	7.30		431038.0185	3974329.6293	55.03
21	Black	7.30		431042.7371	3974327.3855	49.94
660	Black	7.30		431103.6564	3974342.8718	51.99
1316	Black	7.30		431048.9130	3974281.7757	35.46
426	Black	7.20		431065.0195	3974317.0389	26.82
514	Black	7.20		431018.0209	3974313.3982	65.82
685	Black	7.20		431107.9422	3974353.1596	63.13
799	Black	7.20		431075.9439	3974334.4220	38.96
23	Black	7.10		431044.6568	3974322.6613	45.53
808	Black	7.10		431071.3382	3974345.1731	50.35
404	Black	7.00		431062.6597	3974320.5028	31.00
520	Black	7.00		431036.7921	3974273.4444	49.97
1497	Black	7.00		431048.7182	3974269.0264	42.33
1498	Black	7.00		431051.9006	3974281.3345	32.93
1502	Black	7.00		431054.8745	3974281.0449	30.43
1516	Black	7.00		431051.8216	3974277.9642	34.62
1534	Black	7.00		431053.9958	3974276.3552	33.68
1325	Black	7.00		431042.9045	3974280.5315	41.49
1348	Black	7.00		431039.6357	3974267.4661	50.55
1375	Black	7.00		431047.9473	3974265.4037	45.28
1397	Black	7.00		431049.0758	3974262.9750	46.15
1450	Black	7.00		431051.4332	3974258.7946	47.70
1543	Black	7.00		431053.6549	3974275.9578	34.19

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
1548	Black	7.00		431054.4970	3974275.7136	33.66
1549	Black	7.00		431054.9582	3974276.2649	32.96
1551	Black	7.00		431054.2249	3974274.8497	34.39
1571	Black	7.00		431056.6424	3974275.5579	32.06
1574	Black	7.00		431058.2560	3974276.9117	29.95
1577	Black	7.00		431051.8881	3974273.3054	37.19
1579	Black	7.00		431053.0494	3974272.6998	36.65
1592	Black	7.00		431057.2066	3974275.3869	31.74
1607	Black	7.00		431056.5164	3974273.3156	33.62
1621	Black	7.00		431051.6349	3974270.0810	39.42
1642	Black	7.00		431056.5496	3974271.6819	34.71
1646	Black	7.00		431057.6448	3974270.5687	34.74
1653	Black	7.00		431055.7787	3974269.6747	36.67
1902	Black	7.00		431058.1857	3974257.7948	44.61
1922	Black	7.00		431058.7704	3974278.5071	28.56
1931	Black	7.00		431061.9903	3974279.6440	25.33
1961	Black	7.00		431061.4282	3974275.9582	28.23
1979	Black	7.00		431062.0320	3974274.3795	28.96
2222	Black	7.00		431061.2947	3974261.3534	39.96
2233	Black	7.00		431063.3329	3974262.4831	37.98
2100	Black	7.00		431059.7710	3974267.6216	35.60
3682	Black	7.00		431064.9518	3974277.6930	24.54
3687	Black	7.00		431066.3638	3974277.7451	23.58
3689	Black	7.00		431065.9858	3974277.7530	23.81
3694	Black	7.00		431065.2416	3974277.1399	24.76
3696	Black	7.00		431065.5838	3974277.1363	24.54
3702	Black	7.00		431064.3091	3974276.3264	25.99
3738	Black	7.00		431064.7192	3974274.3456	27.26
3756	Black	7.00		431067.9128	3974276.2583	23.82
3763	Black	7.00		431067.3531	3974275.1729	25.03
3799	Black	7.00		431065.4567	3974272.8657	28.01
3827	Black	7.00		431069.7908	3974271.9674	26.58
3859	Black	7.00		431065.7829	3974270.8856	29.48
3880	Black	7.00		431066.2892	3974268.6439	31.15
3939	Black	7.00		431074.8279	3974271.9602	24.80
3960	Black	7.00		431071.7481	3974269.3726	28.21
3996	Black	7.00		431111.8640	3974320.1917	38.94
4020	Grey	7.00		431107.5210	3974324.6232	38.82
4022	Black	7.00		431107.3015	3974327.8793	41.15

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
4051	Black	7.00		431101.5221	3974323.0272	33.78
4111	Black	7.00		431094.0690	3974325.4743	32.19
4115	Black	7.00		431092.8639	3974321.5848	28.15
4122	Black	7.00		431095.9544	3974328.8840	36.07
4155	Grey	7.00		431089.5875	3974333.7240	38.73
4163	Black	7.00		431086.7661	3974326.0213	30.63
4166	Grey	7.00		431085.5294	3974326.6136	31.03
4169	Grey	7.00		431088.1920	3974322.5006	27.48
4177	Black	7.00		431084.7119	3974327.0963	31.41
4190	Black	7.00		431084.0771	3974332.1913	36.43
4212	Black	7.00		431077.3905	3974332.8268	37.20
4217	Black	7.00		431076.2643	3974328.0744	32.64
4228	Black	7.00		431070.2519	3974324.6358	30.89
4243	Black	7.00		431059.1580	3974312.9229	28.09
4260	Black	7.00		431061.1570	3974308.3065	23.82
4283	Black	7.00		431047.3113	3974295.9745	34.15
4308	Black	7.00		431053.1958	3974285.7256	30.03
4329	Black	7.00		431055.9944	3974282.5756	28.72
4355	Black	7.00		431064.7340	3974280.0500	23.01
4362	Black	7.00		431064.0522	3974280.1473	23.45
4377	Black	7.00		431059.3753	3974283.2841	25.41
4382	Black	7.00		431058.6395	3974282.6051	26.39
727	Black	6.90		431093.6067	3974339.6639	45.46
480	Black	6.80	p101	431019.7951	3974348.6642	81.19
485	Black	6.80	p107	431011.0176	3974328.7936	77.77
731	Black	6.80		431092.0894	3974340.1267	45.53
791	Black	6.80		431075.3514	3974352.4877	56.96
812	Black	6.70		431073.6233	3974353.4626	58.14
29	Black	6.50		431045.2682	3974323.6686	45.65
724	Black	6.50		431096.8402	3974348.4483	54.80
737	Black	6.50		431087.8659	3974338.6151	43.24
448	Black	6.40		431073.1923	3974314.5644	20.46
479	Black	6.40	p100	431017.4298	3974351.5226	84.85
640	Black	6.40		431119.4303	3974343.2056	60.70
743	Black	6.40		431084.6511	3974344.1197	48.37
449	Black	6.30		431072.2497	3974314.4602	20.76
681	Black	6.30		431101.9744	3974342.0644	50.56
4	Black	6.20		431002.0588	3974340.6090	91.15
742	Black	6.20		431084.7490	3974344.4748	48.73

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
750	Black	6.20		431091.2893	3974345.4450	50.56
761	Black	6.20		431082.0036	3974365.8207	69.97
850	Black	6.20		431036.0049	3974305.8448	46.54
12	Black	6.10		431018.2955	3974328.3543	71.04
413	Black	6.10		431063.3597	3974317.0789	27.90
815	Black	6.10		431067.0732	3974350.7207	56.72
1496	Black	6.00		431044.7859	3974276.4408	41.50
1514	Black	6.00		431052.5558	3974278.9493	33.49
1524	Black	6.00		431052.4660	3974276.3666	34.93
1529	Black	6.00		431054.1753	3974277.7266	32.76
1365	Black	6.00		431050.0849	3974265.9866	43.32
1392	Black	6.00		431047.7241	3974263.9640	46.42
1448	Black	6.00		431050.7951	3974259.0262	47.92
1535	Black	6.00		431053.8808	3974276.4125	33.74
1537	Black	6.00		431055.6570	3974277.1172	31.89
1545	Black	6.00		431054.4053	3974275.4918	33.86
1546	Black	6.00		431054.2786	3974275.5679	33.92
1563	Black	6.00		431056.2854	3974277.0982	31.39
1564	Black	6.00		431054.9261	3974275.8709	33.22
1582	Black	6.00		431055.0886	3974273.3017	34.70
1670	Black	6.00		431053.1147	3974268.5804	39.34
1673	Black	6.00		431052.7480	3974269.1511	39.21
1715	Black	6.00		431054.8154	3974267.8783	38.63
1734	Black	6.00		431054.5820	3974265.7737	40.34
1864	Black	6.00		431059.4084	3974260.9771	41.26
1952	Black	6.00		431061.4246	3974277.1927	27.38
1981	Black	6.00		431061.4904	3974274.5828	29.18
1989	Black	6.00		431059.4221	3974275.5386	29.97
2106	Black	6.00		431060.3070	3974267.0736	35.72
3699	Black	6.00		431064.9008	3974276.8059	25.24
3719	Black	6.00		431066.7318	3974276.4340	24.37
3736	Black	6.00		431064.4234	3974275.3581	26.65
3798	Black	6.00		431065.3353	3974273.0426	27.93
3810	Black	6.00		431067.8778	3974272.9776	26.60
3820	Black	6.00		431069.1025	3974272.7090	26.24
3861	Black	6.00		431066.0902	3974271.1519	29.09
3915	Black	6.00		431068.7443	3974264.1645	34.14
3933	Black	6.00		431073.0210	3974261.2197	35.65
3994	Black	6.00		431105.5026	3974316.5498	31.72

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
4006	Black	6.00		431100.6857	3974317.8701	29.23
4010	Black	6.00		431102.4223	3974318.5939	30.93
4045	Black	6.00		431095.4896	3974320.0718	27.99
4053	Grey	6.00		431100.9808	3974325.5482	35.54
4068	Black	6.00		431104.0405	3974333.7493	44.11
4070	Black	6.00		431102.5787	3974333.8674	43.49
4078	Black	6.00		431099.5040	3974334.0044	42.20
4089	Black	6.00		431094.0423	3974322.1027	29.11
4093	Black	6.00		431093.8749	3974322.7610	29.63
4094	Black	6.00		431093.8135	3974322.9275	29.76
4098	Black	6.00		431096.1052	3974323.2266	31.04
4105	Black	6.00		431098.5097	3974333.7246	41.53
4112	Black	6.00		431095.1232	3974324.7937	32.00
4114	Black	6.00		431091.6948	3974321.6329	27.74
4120	Black	6.00		431095.1953	3974329.4489	36.29
4123	Black	6.00		431097.1955	3974328.2569	36.02
4139	Black	6.00		431094.7170	3974323.3550	30.53
4140	Black	6.00		431092.3024	3974324.3221	30.46
4143	Black	6.00		431088.4542	3974320.6650	25.78
4179	Black	6.00		431084.2943	3974327.9462	32.22
4198	Black	6.00		431083.2116	3974324.3811	28.58
4210	Black	6.00		431077.5255	3974334.4664	38.81
4213	Black	6.00		431078.9569	3974330.2821	34.52
4214	Black	6.00		431078.6422	3974329.9032	34.17
4215	Black	6.00		431077.7788	3974326.6896	31.06
4241	Black	6.00		431055.6996	3974313.2180	31.07
4281	Black	6.00		431051.9143	3974297.5760	29.60
4285	Black	6.00		431054.4279	3974295.5799	27.03
4299	Black	6.00		431057.0690	3974292.7478	24.59
4301	Black	6.00		431048.7795	3974288.0033	33.61
4304	Black	6.00		431052.8999	3974288.4964	29.49
4316	Black	6.00		431054.1594	3974288.1508	28.37
4331	Black	6.00		431054.8179	3974282.0420	30.01
4384	Black	6.00		431059.1376	3974282.2456	26.14
711	Black	5.90		431098.4033	3974345.4473	52.41
811	Black	5.90		431072.3853	3974350.1779	55.08
450	Black	5.80		431071.3872	3974314.9102	21.56
658	Black	5.80		431105.2501	3974340.2682	50.38
776	Black	5.80		431083.6755	3974341.0369	45.24

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
833	Black	5.80		431026.2370	3974337.8292	69.37
670	Black	5.70		431103.7310	3974336.4367	46.29
427	Black	5.60		431064.5694	3974318.6519	28.37
465	Black	5.60		431072.0516	3974311.9969	18.69
773	Black	5.60		431083.5627	3974343.6523	47.85
510	Black	5.50		431022.1941	3974317.5462	63.11
648	Black	5.50		431113.4236	3974341.5557	55.77
673	Black	5.50		431102.3057	3974335.5145	44.81
783	Black	5.50		431079.7051	3974341.5800	45.76
793	Black	5.50		431077.1035	3974363.8464	68.13
25	Black	5.40		431051.7235	3974324.0855	41.01
30	Black	5.40		431047.3808	3974329.1273	47.63
717	Black	5.40		431097.2238	3974339.7082	46.60
779	Black	5.40		431080.7200	3974338.9670	43.12
517	Black	5.30		431026.5215	3974303.8319	55.52
843	Black	5.30		431041.2974	3974312.7046	43.56
668	Black	5.20		431112.3849	3974342.1751	55.70
748	Black	5.20		431092.2857	3974342.5074	47.89
749	Black	5.20		431092.6254	3974342.2030	47.68
772	Black	5.20		431082.9860	3974345.1277	49.30
802	Black	5.20		431074.9843	3974343.2994	47.89
723	Black	5.10		431099.9777	3974365.0242	71.61
775	Black	5.10		431085.2117	3974340.4166	44.72
820	Black	5.10		431064.1579	3974344.7137	51.83
735	Black	5.00		431082.6210	3974335.1743	39.34
1500	Black	5.00		431051.3354	3974278.8866	34.57
1505	Black	5.00		431055.6459	3974280.3232	30.13
1507	Black	5.00		431053.5104	3974278.6615	32.81
1511	Black	5.00		431057.0646	3974278.8016	29.76
1512	Black	5.00		431057.3826	3974280.1628	28.74
1523	Black	5.00		431052.8786	3974277.6963	33.86
1346	Black	5.00		431041.4429	3974269.6867	47.81
1358	Black	5.00		431049.4797	3974267.7648	42.56
1417	Black	5.00		431050.1216	3974261.3050	46.64
1433	Black	5.00		431049.1520	3974258.6477	49.28
1465	Black	5.00		431052.1451	3974258.2339	47.69
1541	Black	5.00		431057.2831	3974278.1820	29.95
1542	Black	5.00		431056.0040	3974277.7480	31.24
1552	Black	5.00		431054.0481	3974274.5775	34.70

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
1671	Black	5.00		431053.3066	3974268.7805	39.06
1830	Black	5.00		431058.0467	3974264.6766	38.99
1862	Black	5.00		431058.8949	3974261.3330	41.24
3700	Black	5.00		431064.5526	3974276.9126	25.39
3767	Black	5.00		431068.5927	3974275.7450	23.87
3787	Black	5.00		431065.4294	3974273.3560	27.62
3794	Black	5.00		431064.7798	3974273.5919	27.82
3805	Black	5.00		431066.9385	3974272.5177	27.49
3851	Black	5.00		431070.1649	3974271.1092	27.20
4018	Black	5.00		431106.4457	3974320.2751	34.94
4038	Grey	5.00		431099.6266	3974320.6674	30.75
4103	Black	5.00		431099.2836	3974330.8636	39.29
4104	Black	5.00		431098.9387	3974334.2071	42.15
4118	Black	5.00		431092.7913	3974326.0670	32.27
4119	Black	5.00		431092.9127	3974327.2724	33.44
4131	Grey	5.00		431096.2307	3974331.1364	38.25
4137	Black	5.00		431090.8705	3974322.9124	28.65
4141	Black	5.00		431090.2444	3974323.4284	28.94
4142	Black	5.00		431088.5276	3974321.1773	26.29
4145	Black	5.00		431089.1916	3974326.7671	31.87
4151	Black	5.00		431094.8360	3974335.3776	41.73
4157	Grey	5.00		431088.9067	3974334.6096	39.47
4167	Black	5.00		431085.8373	3974326.1959	30.66
4231	Black	5.00		431070.6730	3974329.5096	35.34
4257	Black	5.00		431060.1073	3974309.3049	25.24
4309	Black	5.00		431052.9838	3974285.8822	30.17
4311	Black	5.00		431052.9309	3974283.4096	31.13
4315	Black	5.00		431054.1319	3974289.3558	28.09
4325	Black	5.00		431058.5657	3974284.0537	25.76
4335	Black	5.00		431060.4675	3974286.8309	22.85
4348	Black	5.00		431062.6990	3974282.6632	22.93
4391	Black	5.00		431057.3658	3974280.9504	28.33
822	Black	4.90		431067.4140	3974337.8310	44.27
3	Black	4.80		431001.8793	3974330.0085	86.60
541	Black	4.80		431040.8071	3974256.3982	56.65
616	Black	4.80		431066.2732	3974246.5339	51.60
710	Black	4.80		431099.0725	3974347.0639	54.15
778	Black	4.80		431080.4552	3974336.7189	40.88
797	Black	4.80		431072.8347	3974352.0348	56.84

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
774	Black	4.70		431085.4536	3974340.5449	44.87
633	Black	4.60		431123.3170	3974334.3683	56.88
786	Black	4.60		431078.9239	3974347.9682	52.18
417	Black	4.50		431061.4860	3974314.8714	27.58
781	Black	4.50		431078.7757	3974339.1839	43.41
801	Black	4.50		431072.5895	3974340.2246	45.25
451	Black	4.40		431070.5842	3974314.9348	21.96
511	Black	4.40		431022.0876	3974319.5282	63.92
705	Black	4.40		431097.1884	3974359.1713	65.24
810	Black	4.40		431074.1127	3974349.6423	54.29
421	Black	4.30		431059.6615	3974313.0539	27.77
709	Black	4.30		431098.5009	3974353.3192	59.94
722	Black	4.30		431098.7188	3974362.6051	68.95
762	Black	4.30		431082.1405	3974369.5442	73.69
769	Black	4.30		431081.1240	3974344.1781	48.33
784	Black	4.30		431079.1533	3974345.0244	49.23
410	Black	4.20		431057.2368	3974317.9168	32.77
481	Black	4.20	p102	431021.4412	3974342.8669	76.24
713	Black	4.20		431095.4794	3974342.9333	49.12
819	Black	4.20		431072.3653	3974334.3318	39.54
844	Black	4.20		431040.9019	3974313.3917	44.19
8	Black	4.10		431010.3488	3974332.4522	79.98
537	Black	4.10		431039.3089	3974248.6342	63.30
740	Black	4.10		431087.4098	3974343.1071	47.63
777	Black	4.10		431082.1891	3974342.1246	46.28
780	Black	4.10		431080.1594	3974339.6892	43.86
824	Black	4.10		431065.9363	3974339.1782	46.02
771	Black	4.00		431080.9665	3974343.8069	47.96
817	Black	4.00		431070.1690	3974342.5671	48.06
1601	Black	4.00		431058.0079	3974274.2127	31.91
3709	Black	4.00		431065.2936	3974276.0971	25.53
3713	Black	4.00		431065.8660	3974276.4897	24.86
3905	Black	4.00		431065.4673	3974266.2708	33.63
3918	Black	4.00		431066.9805	3974263.5359	35.41
4015	Black	4.00		431104.0074	3974320.5910	33.47
4090	Black	4.00		431094.1263	3974322.1617	29.20
4132	Grey	4.00		431094.4065	3974327.5065	34.20
4133	Black	4.00		431094.9091	3974327.2284	34.14
4134	Black	4.00		431094.1057	3974328.1037	34.64

TABLE III-G-1. (Contd.)

OBJECTID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, m
4138	Black	4.00		431090.6914	3974322.5778	28.27
4178	Black	4.00		431084.6416	3974327.3499	31.66
4187	Black	4.00		431084.1195	3974333.6601	37.90
4232	Black	4.00		431069.8852	3974330.9487	36.96
4354	Black	4.00		431064.4285	3974280.3790	23.01
436	Black	3.90		431069.0329	3974317.3812	24.86
2	Black	3.70		431001.1783	3974332.1004	88.09
11	Black	3.30		431013.1475	3974333.9014	78.20
486	Black	3.20	p108	431011.2729	3974325.9969	76.39
4183	Black	3.00		431086.2890	3974329.2720	33.77
10	Black	2.80		431015.2029	3974331.6980	75.33
		7476.40				

FRAGMENT MAPS FOR EACH OF THE DEBRIS WEIGHT GROUPS AND PHOTOGRAPHS OF INDIVIDUAL FRAGMENTS

This section presents the fragment maps for each of the weight groups presented in Chapter III in Figures III-32 and III-33.

Figures III-G-1 through III-G-36 summarize the fragment locations by weight fraction. Photographs of typical fragments in a given weight fraction are also shown for the larger fragments. Figure III-G-1 shows the location of the largest fragment (red data point) found in Test 2. This fragment weighed 8,400 g. The fragment location (Figure III-G-1) corresponds to a distance 37 m (121.4 feet) from the center line of the original structure.

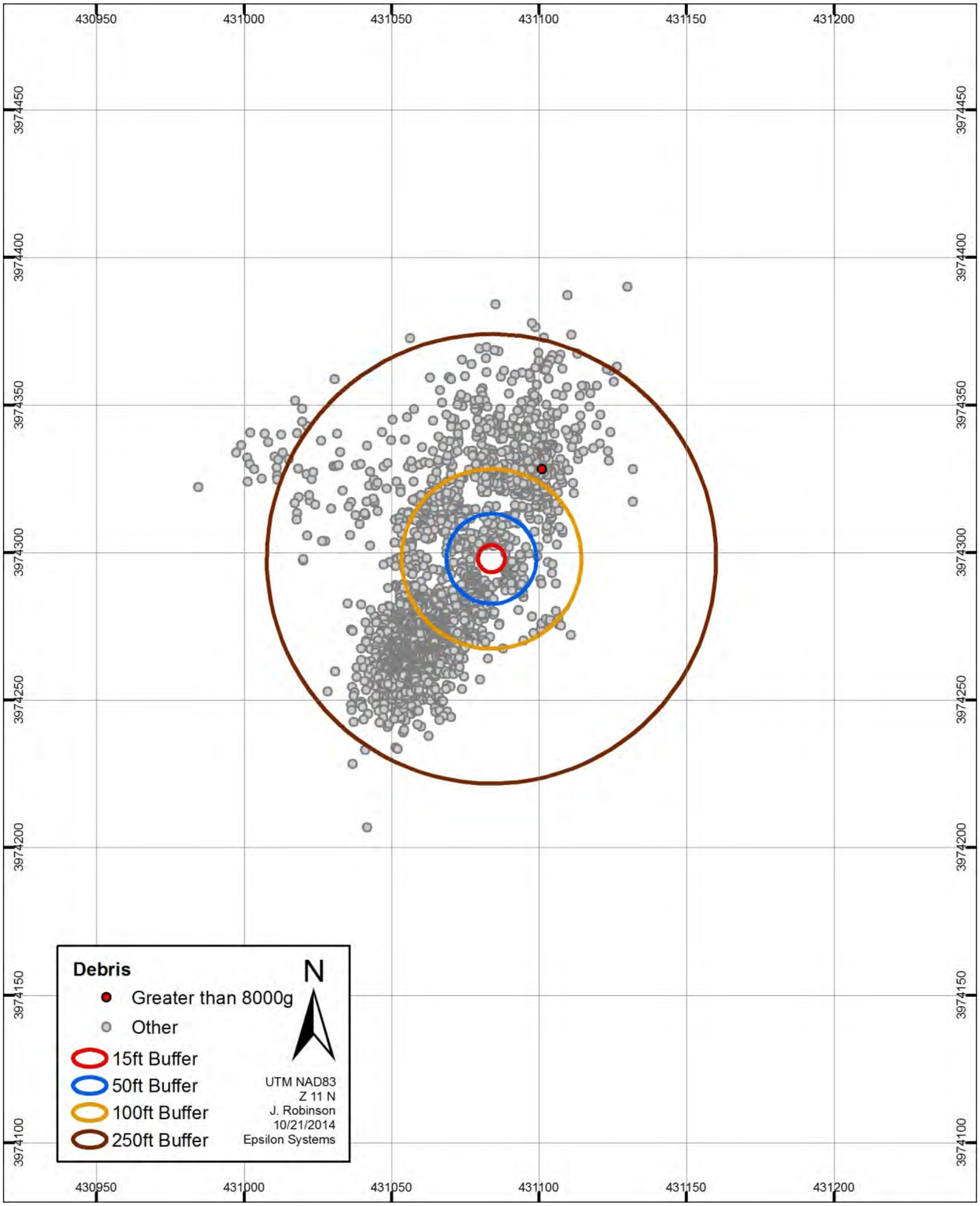

FIGURE III-G-1. Location Where the Largest Fragment (8,400 g) Was Found (Test 2) Approximately 37 m From the Center Line of the Original Structure.

Figure III-G-2 shows a photograph of this very large fragment. This fragment was black concrete under the white coating, indicating that it came from the roof of the structure. The fragment in question was an edge piece adjacent to the north wall.

FIGURE III-G-2. Photograph of Largest Fragment (8,400 g)
With Location Coordinates (Test 2).

This fragment was interesting, not only because it was the largest fragment found, but because we were able to find fragments that had been adjacent to this fragment in the original structure (Figure III-G-3). The largest fragment (8,400 g) is on the left in Figure III-G-2. All of these fragments were black concrete with the squared edge, indicating that they were originally the north edge of the roof.

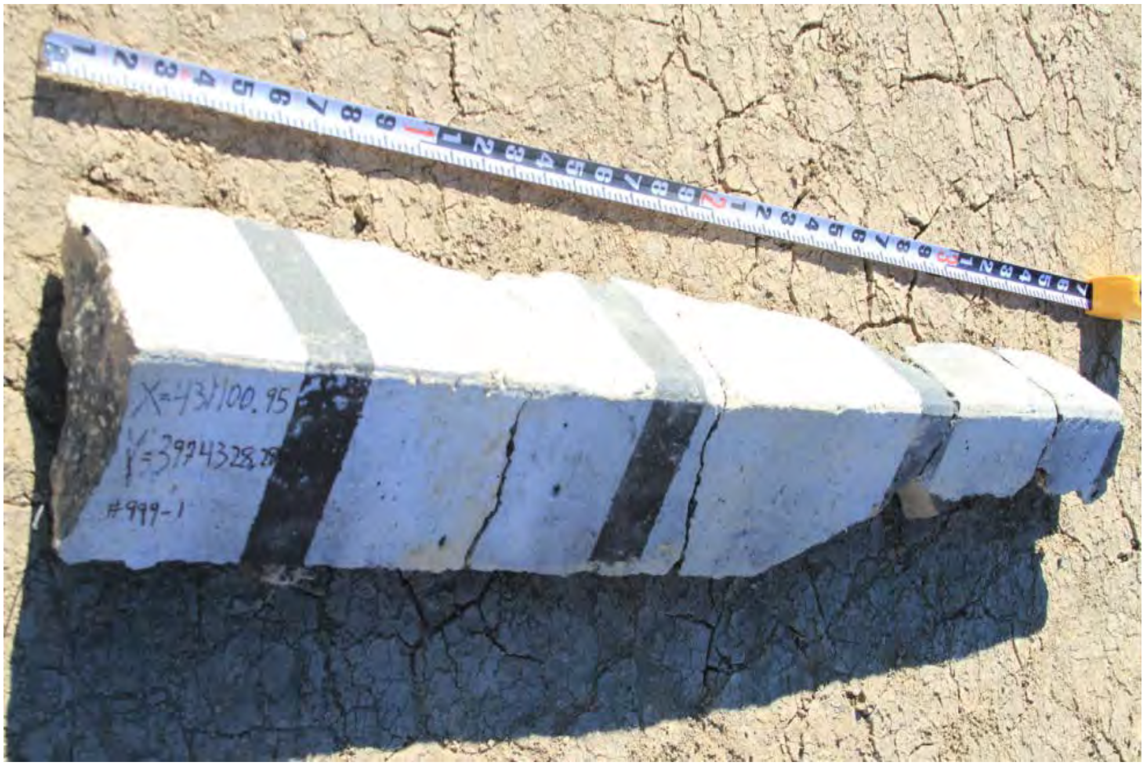

FIGURE III-G-3. Fragments Originally Adjacent to One Another in the Undamaged Structure (Test 2). The largest fragment shown in Figure III-G-2 appears on the left in this figure.

Figure III-G-4 shows the locations of fragments weighing 7,000 to 7,999.9 g. The red dots in the plot indicate the location that these fragments were found.

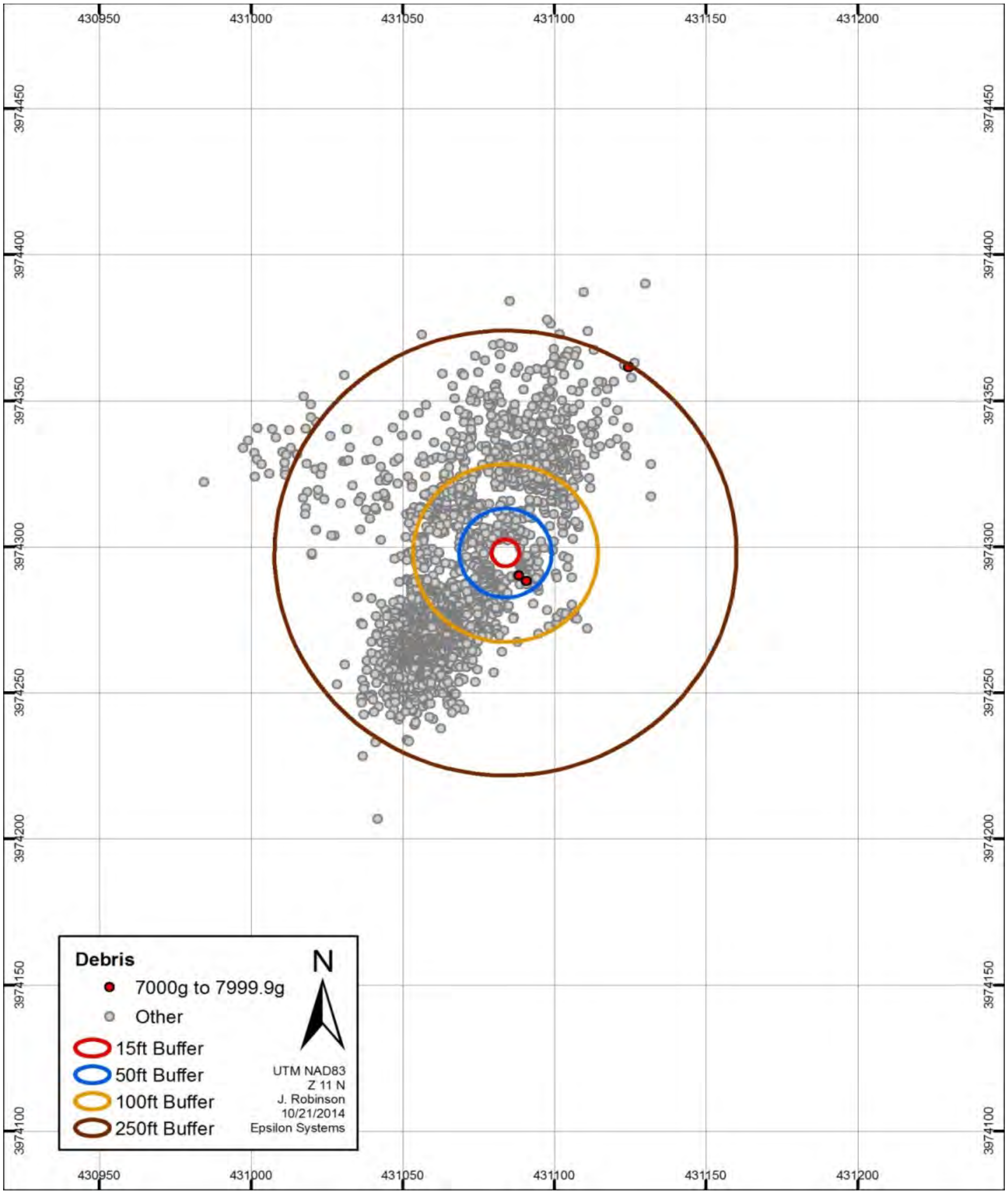

FIGURE III-G-4. Locations of Fragments That Weighed 7,000 to 7,999.9 g (Test 2).

The fragment found north-northeast of the structure in Figure III-G-4 weighed 7,082 g and was black, indicating that it came from the roof. The fragment was found 77 m from the center of the structure.

The other two fragments were located in relatively close proximity to one another in the area just southeast of the structure. The fragment located closest to the structure is

shown in Figure III-G-5 and was found 9.9 m from the center of the structure. This edge fragment from the roof on the east side weighed 7,260 g.

FIGURE III-G-5. Fragment Weighing 7,260 g Found Southeast of the Structure (Test 2).

Another fragment is shown in Figure III-G-6. The fragment shown in Figure III-G-5 was found slightly to the southeast of the fragment shown in Figure III-G-6. This two-part fragment was found 12.7 m from the center of the structure evidently fractured on impact. The total weight of the two pieces was 7,055 g.

FIGURE III-G-6. Fragment Found to the Southwest of Structure
With a Total Weight of 7,055 g (Test 2).

There was only one fragment in the 6,000- to 6,999.9-g range. The location of this fragment, found to the north and west of the structure, is indicated by the red dot in Figure III-G-7. The fragment weighed 6,665 g.

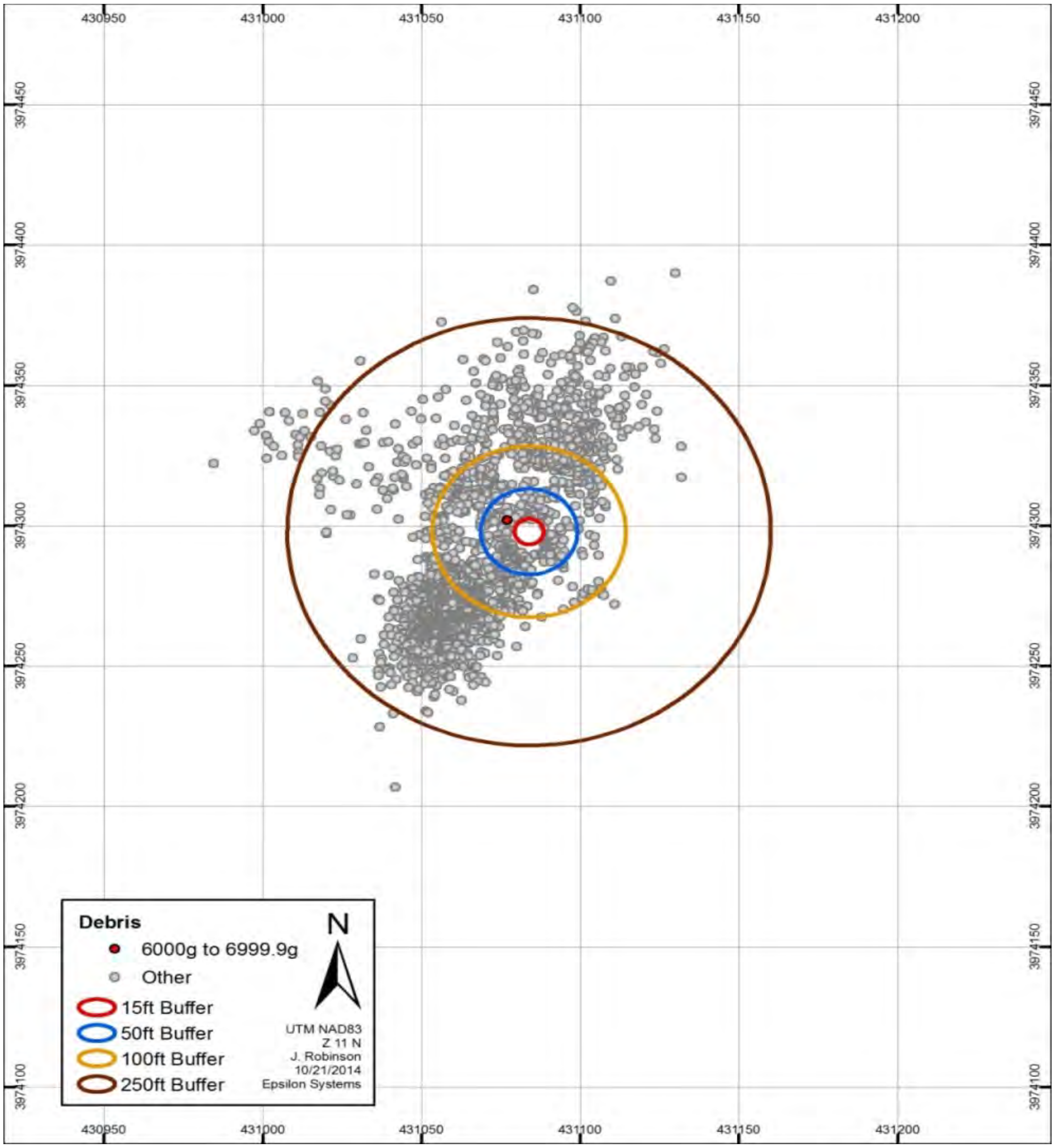

FIGURE III-G-7. Single Fragment Wound in the 6,000- to 6,999.9-g Range (Test 2).

Figure III-G-8 shows the single fragment referred to in Figure III-G-7. This fragment was found only 6.4 m from the center of the original structure. The gray color of the concrete indicates that this fragment came from the north wall. This fragment weighed 6,665 g. The very distinct impression of the rebar with the raised ribs is shown, indicating that the concrete surrounding the rebar had fractured releasing the rebar rather than the rebar being pulled through the concrete. Rebar being pulled through the concrete would have obliterated the rib indentations. Evidence of this type of failure is shown in the fragments depicted in Figures III-G-1 and III-G-5.

FIGURE III-G-8. Fragment Weighing 6,665 g Found Northwest of Structure (Test 2).

Figure III-G-9 shows the locations of the four fragments in the 5,000- to 5,999.9-g weight range. All of the fragments were black concrete, indicating that they originated from the roof. The weights were 5,815; 5,725; 5,594; and 5,130 g.

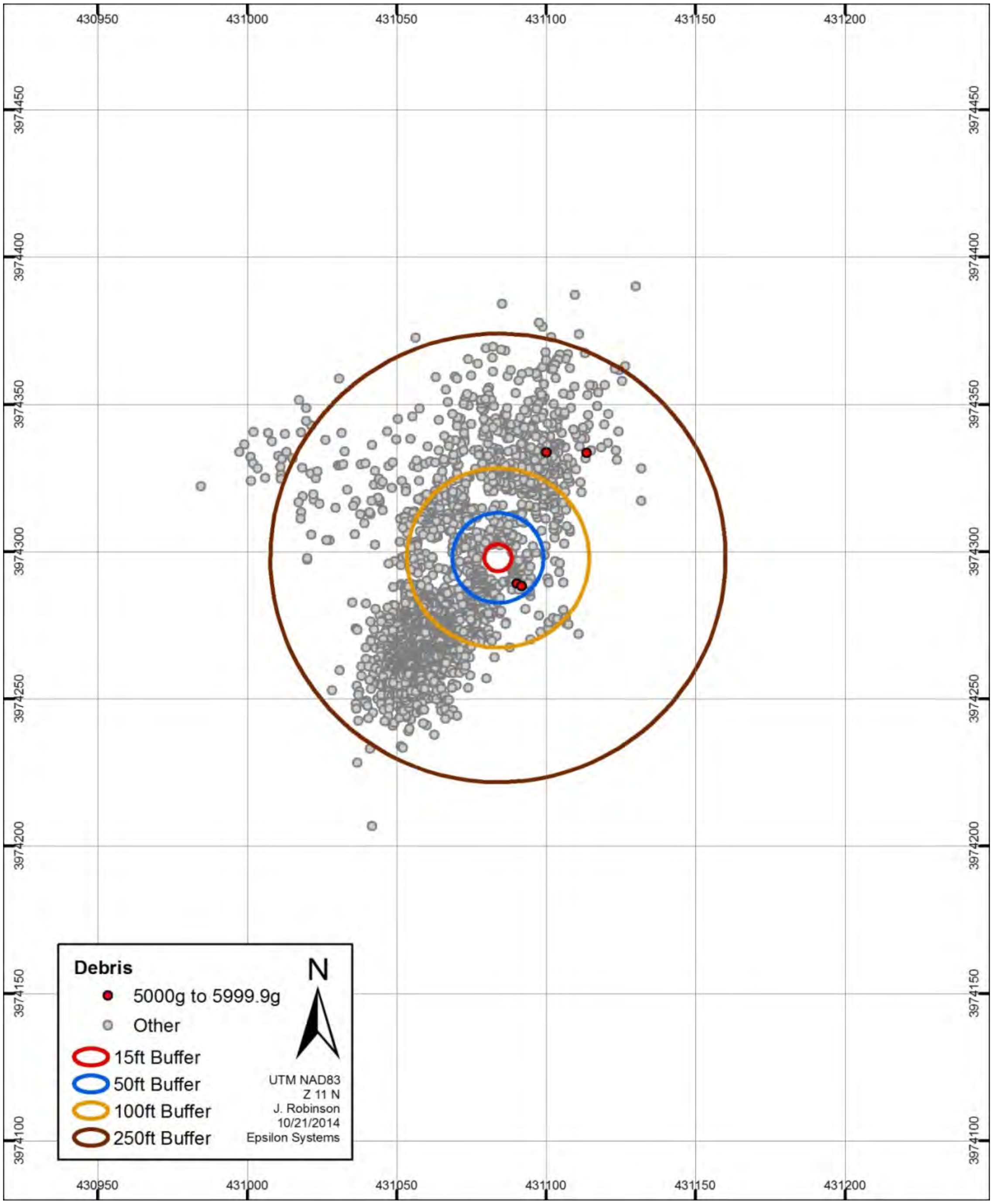

FIGURE III-G-9. Locations of Fragments Having Weights
in the 5,000- to 5,999.9-g Range (Test 2).

Figure III-G-10 shows the 5,815-g fragment that is approximately 1.4-feet long that traveled 12 m from the original center of structure. The 5,725-g fragment traveled 48 m from the structure.

FIGURE III-G-10. Fragment Weighing 5,815 g Found 12 m South of the Structure (Test 2).

The locations where fragments weighing between 4,000 and 4,999.9 g were found are presented in Figure III-G-11.

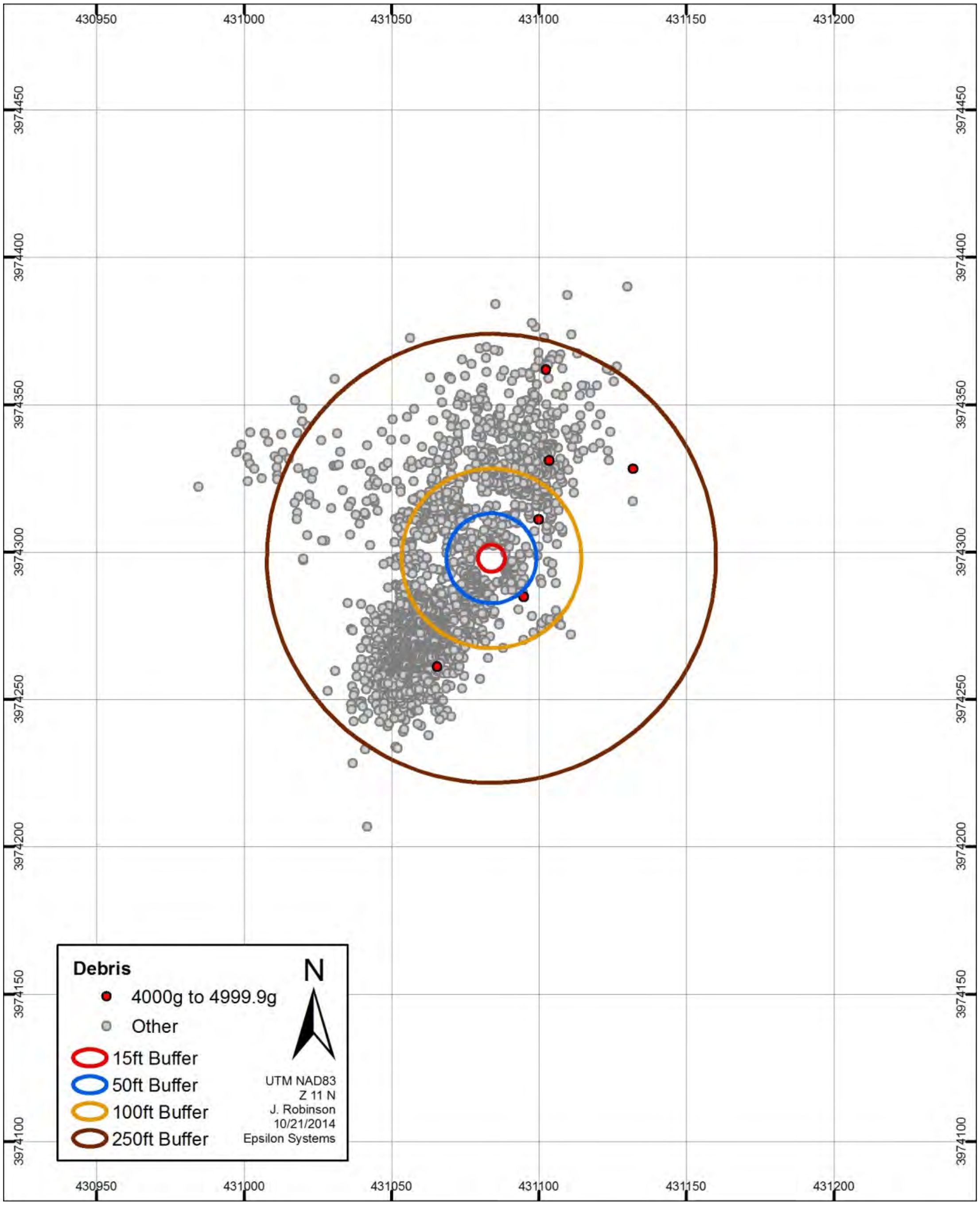

FIGURE III-G-11. Locations of Fragments Having Weights Between 4,000 and 4,999.9 g (Test 2).

The heaviest fragment in the 4,000- to 4,999.9-g weight range was 4,958 g and is shown in Figure III-G-12. The fragment was found 34 m from the center of the structure. The northernmost fragment in the 4,000- to 4,999.9-g weight range was found approximately 68 m from the center of the original structure and weighed 4,499 g. The fragment in question, like most of the fragments, was originally part of the roof. The

easternmost fragment collected from the 4,000- to 4,999.9-g category weighed 4,805 g and was found 60 m from the center of the original structure. This fragment had also originally been part of the roof.

FIGURE III-G-12. Largest Fragment in the 4,000- to 4,999.9-g Weight Category at 4,958 g (Test 2) Found 40.5 m From the Center of the Original Structure Location.

The southernmost fragment in the 4,000- to 4,999.9-g weight range was two lengths of rebar that were still tied together by wire weighing 4,020 g. There were many single pieces of rebar found in other locations. Most of those weighed approximately 2,000 g.

Figure III-G-13 presents the locations for fragments having mass between 3,000 and 3,999.9 g.

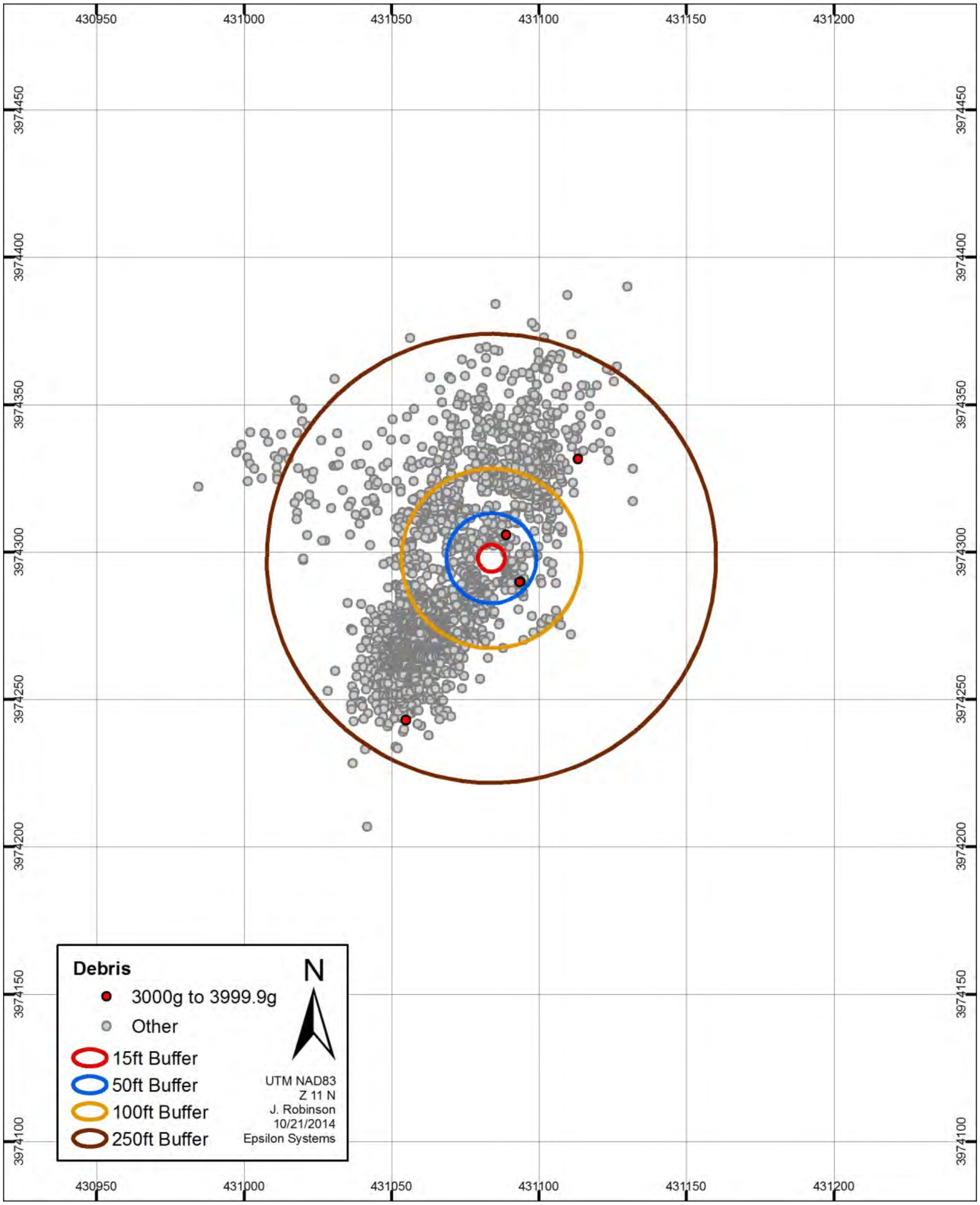

FIGURE III-G-13. Locations Where Fragments Weighing Between 3,000 and 3,999.9 g Were Found (Test 2).

A fragment weighing 3,856 g was found in the northeast 47 m from the center of the original structure. Figures III-G-14 and III-G-15 present two fragments that were found close to and east-southeast of the original structure site. The two fragments were found adjacent to one another (the data points in Figure III-G-13 overlap) and were both corners of the roof. One fragment weighed 3,175 g and the other weighed 3,125 g.

FIGURE III-G-14. One of Two Roof Fragments Found Adjacent to One Another Very Near to the Original Structure Site (Test 2). This fragment weighed 3,175 g.

FIGURE III-G-15. One of Two Roof Fragments Found Adjacent to One Another Very Near to the Original Structure Site (Test 2). This fragment weighed 3,125 g.

The southernmost fragment in Figure III-G-13 weighed 3,024 g and was located 60 m from the original structure site.

Figure III-G-16 presents the locations of fragments weighing between 2,000 and 2999.9 g. There were many fragments in this weight range. Also of interest, several of the fragments were gray concrete indicating that they had been part of the front (north) wall. All of these fragments were in the northern sector and not far from the original structure site. The location of these fragments is probably an indication that the north wall/door did not fail and was not a source of fragments until after the roof had started to fail, thus relieving internal pressure. The decreased pressure not only failed to cause significant fragments, but it also did not project them very far. One of the fragments that was found on the east side, not far from the original structure site, had both black and gray concrete, indicating that it had come from the roof-front wall joint. Some of the fragments were bare rebar (no concrete) with weights of about 2,000 g. (There were also several rebar lengths in the 1,700- to 1,900-g range.)

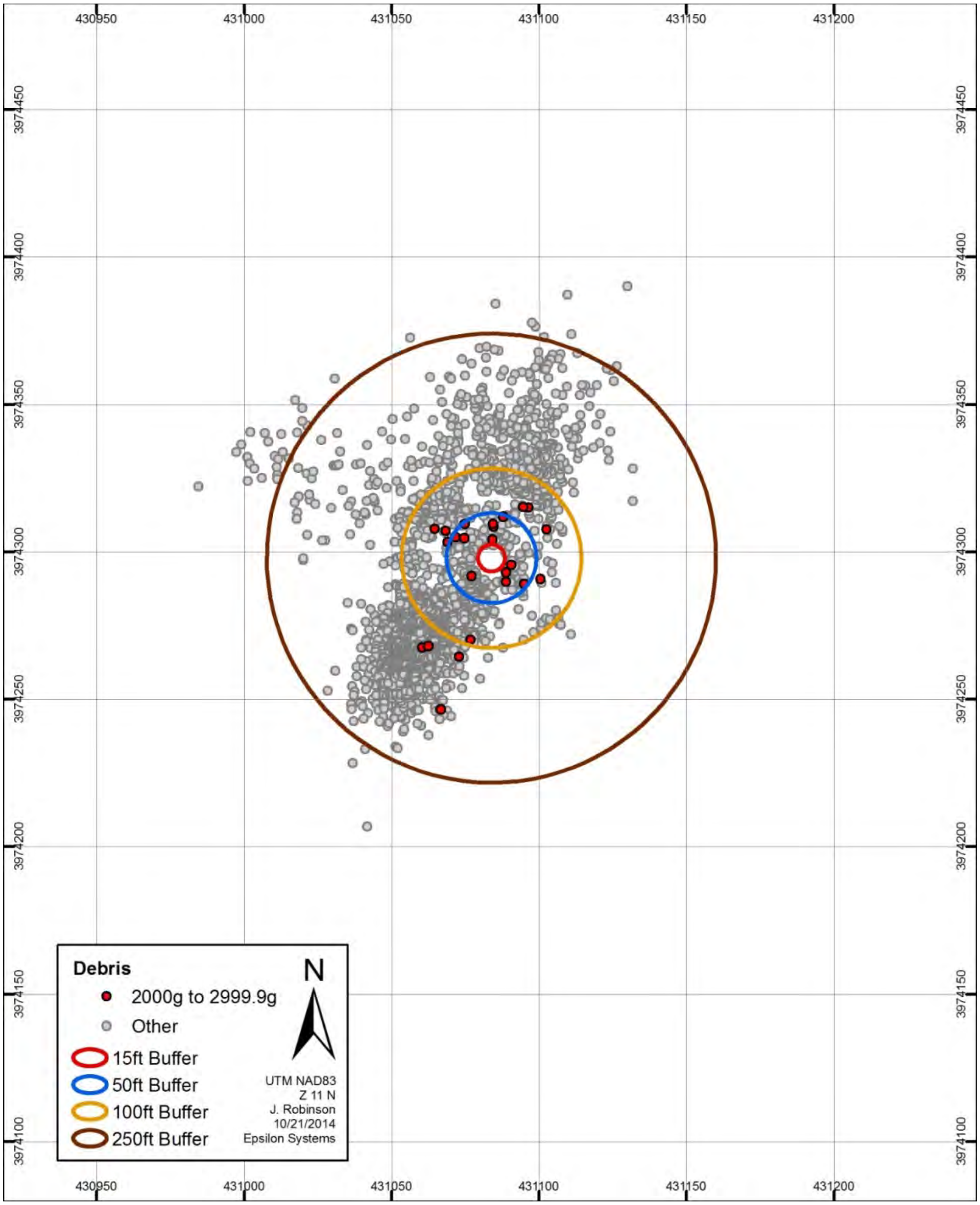

FIGURE III-G-16. Locations of Fragments Weighing Between 2,000 and 2,999.9 g (Test 2).

The southernmost fragment in this weight range weighed 2,372 g and was found 52 m from the center of the original structure.

Figure III-G-17 presents a fragment that weighed 2,925 g. This fragment is interesting because it, like many other fragments, shows the impression of where the

concrete had originally been encasing rebar, and the impression of the ribs on the rebar are clearly evident.

FIGURE III-G-17. Fragment That Weighed 2,925 g (Test 2). Note that the structure indicating where rebar had been located in the original undamaged concrete.

Figure III-G-18 presents a photograph of a roof fragment from where the roof, west wall, and north wall came together. This fragment weighed 2,705 g, did not travel very far, and was found 10 m from the center of the original structure.

FIGURE III-G-18. Fragment That Originally had Been the Corner of the Roof, West Wall, and North Wall (Test 2). This fragment weighed 2,705 g.

Figure III-G-19 presents three fragments that were originally part of the north wall. The weights and locations were as follows: (a) 2,865 g at location X431071 Y3974305, (b) 2,790 g at location X431085 Y3974308, and (c) 2,605 g at location X431084 Y3974304. These fragments were found not far from the original position of the north wall. Fragment (b) is interesting, because it is one of the few fragments that has evidence of rebar being pulled through the concrete as evidenced by the smooth bore (no impression of the ribs) of the vertical indentation as opposed to the horizontal that shows the impression of the rebar with associated ribs that was seen in so many of the fragments.

(a) 2,865 g at location X431071 Y3974305.

(b) 2,790 g at location X431085 Y3974308.

FIGURE III-G-19. Fragments From the North Wall With Weights and Locations as Indicated (Test 2).

(c) 2,605 g at location X431084 Y3974304.

FIGURE III-G-19. Contd.

Figure III-G-20 presents a fragment that weighed 2,134 g that was found approximately 20 m southeast from the center of the original location of the structure.

FIGURE III-G-20. Fragment Weighing 2,134 g That Was Found Approximately 20 m Southeast of the Center of the Structure (Test 2).

Figure III-G-21 presents the fragment map for fragments having mass between 1,500 and 1999.9 g. The farthest fragment in the southwest area of the figure was a roof fragment weighing 1,671 g found 75 m from the center of the structure. Nine of the fragments in this weight range were bare rebar. All of the concrete fragments were black, indicating that they all came from the roof, with the exception of two gray fragments that came from the front wall, and one black and gray fragment that came from the bond-line between the front wall and roof. The gray fragments weighed 1,665 g fot the fragment found 9 m east of the front wall and 1,565 g for the fragment found 13 m east of the front wall. The black and gray fragment weighed 1,940 g and was found 22 m east of the north wall.

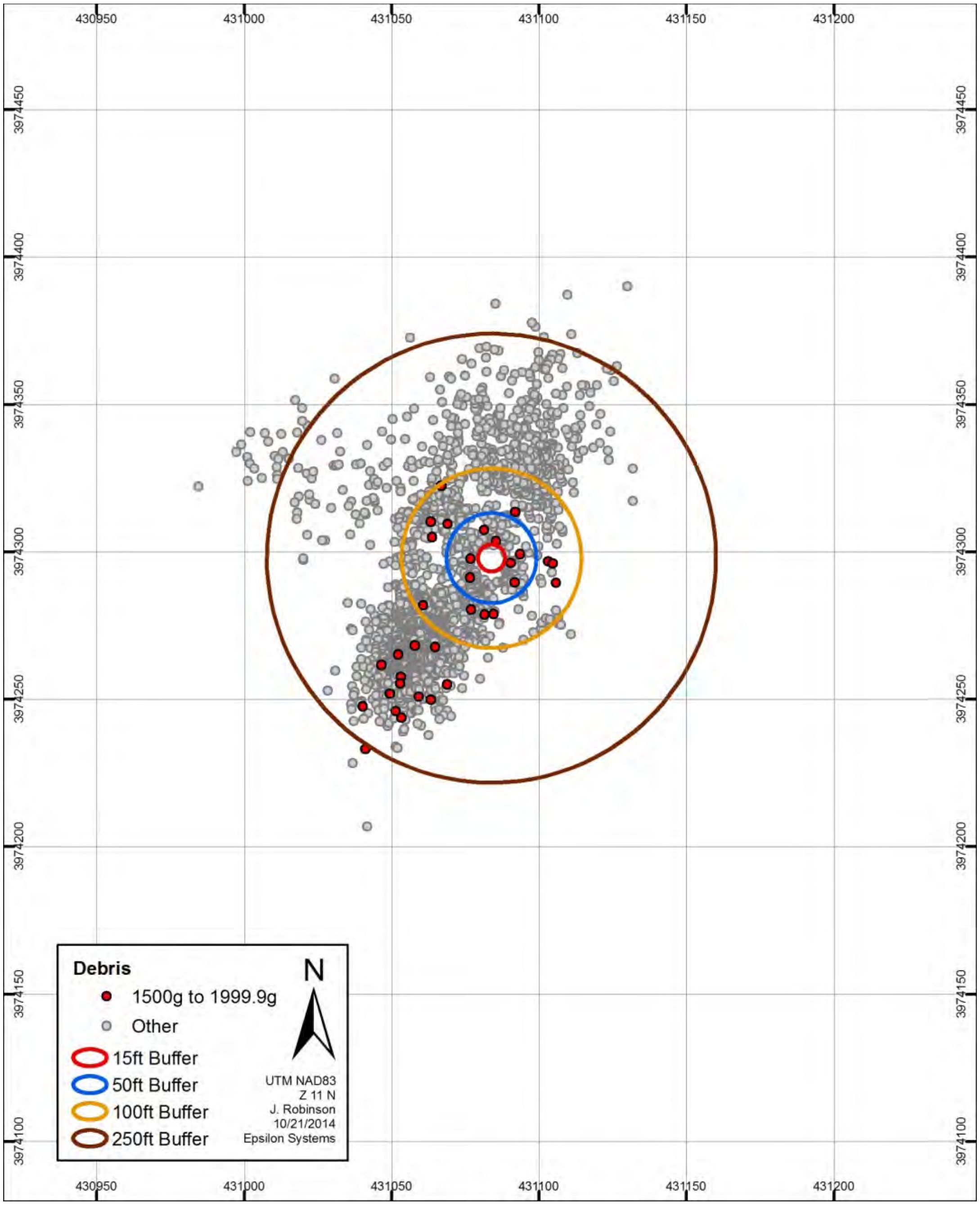

FIGURE III-G-21. Fragment Map of Fragments Weighing Between 1,500 and 1,999.9 g (Test2).

Figure III-G-22 presents the fragment map of fragments weighing between 1,000 and 1,499.9 g. The furthermost fragment weighed 1,438 g and was found at 70 m southwest from the center of the structure. There were five gray fragments and a drum lid in the distribution of fragments in this range.

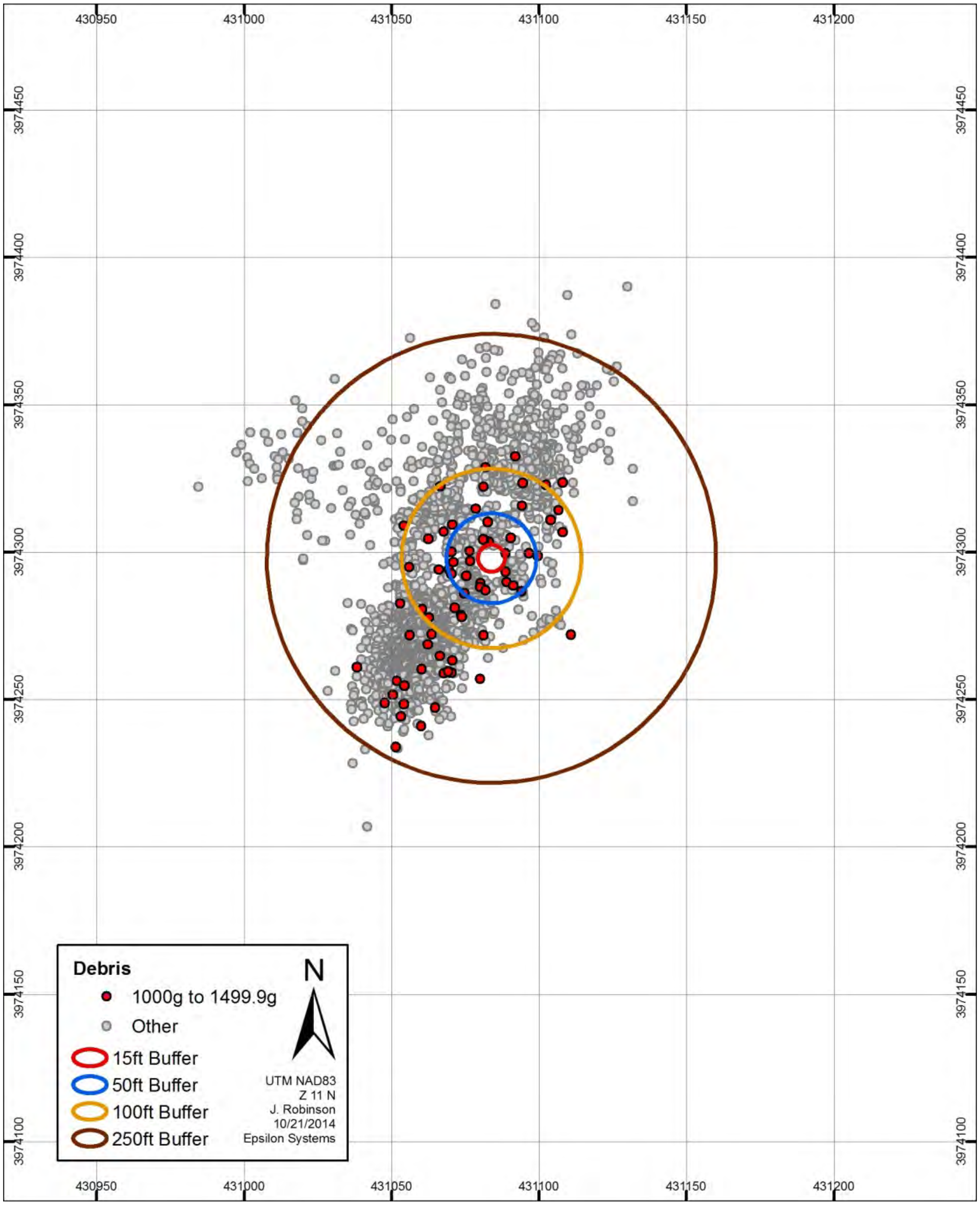

FIGURE III-G-22. Fragment Map of Fragments Between 1,000 and 1,499.9 g (Test 2).

Figure III-G-23 is a photograph of a fragment from the north wall that weighed 1,485 g and was found directly north of the north wall at a distance of 7 m from the center of the structure. There is evidence of rebar being pulled though the concrete (no rib pattern and detritus) on the right and evidence for the concrete cracking away from the rebar (impression of the rebar and ribs) on the left.

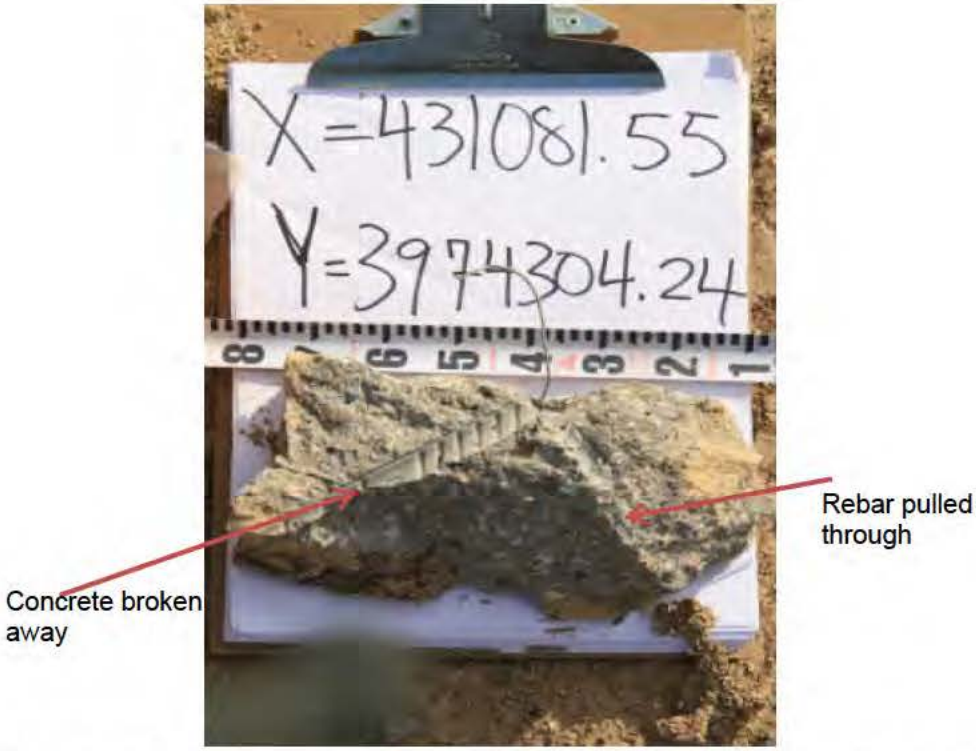

FIGURE III-G-23. Fragment Weighing 1,485 g From North Wall That Was Found 7 m North of North Wall (Test 2). Note the evidence for rebar being pulled through concrete on the right with perpendicular rebar impression with ribs indicating that the adjacent concrete fractured from rebar.

The farthest fragment found that was in the range of the 800- to 999.9-g was a 900 g roof fragment found at 67 m southwest from the center of the original structure. The farthest fragment in the northeast was an 816 g roof fragment at approximately 55 m from the center of the structure. There were three gray fragments from the front wall and 42 black fragments from the roof.

Figure III-G-25 presents the fragment map for the 600- to 799.9-g fragments. The largest fragment in this category was 799 g while the smallest was 603 g. The northernmost fragments are a 779-g roof fragment 72 m from the center of the structure and a 737-g roof fragment 71 m from the center of the structure. The southernmost fragments are a 704-g roof fragment 64 m from the center of the structure and a 740-g fragment 65 m from the center of the structure.

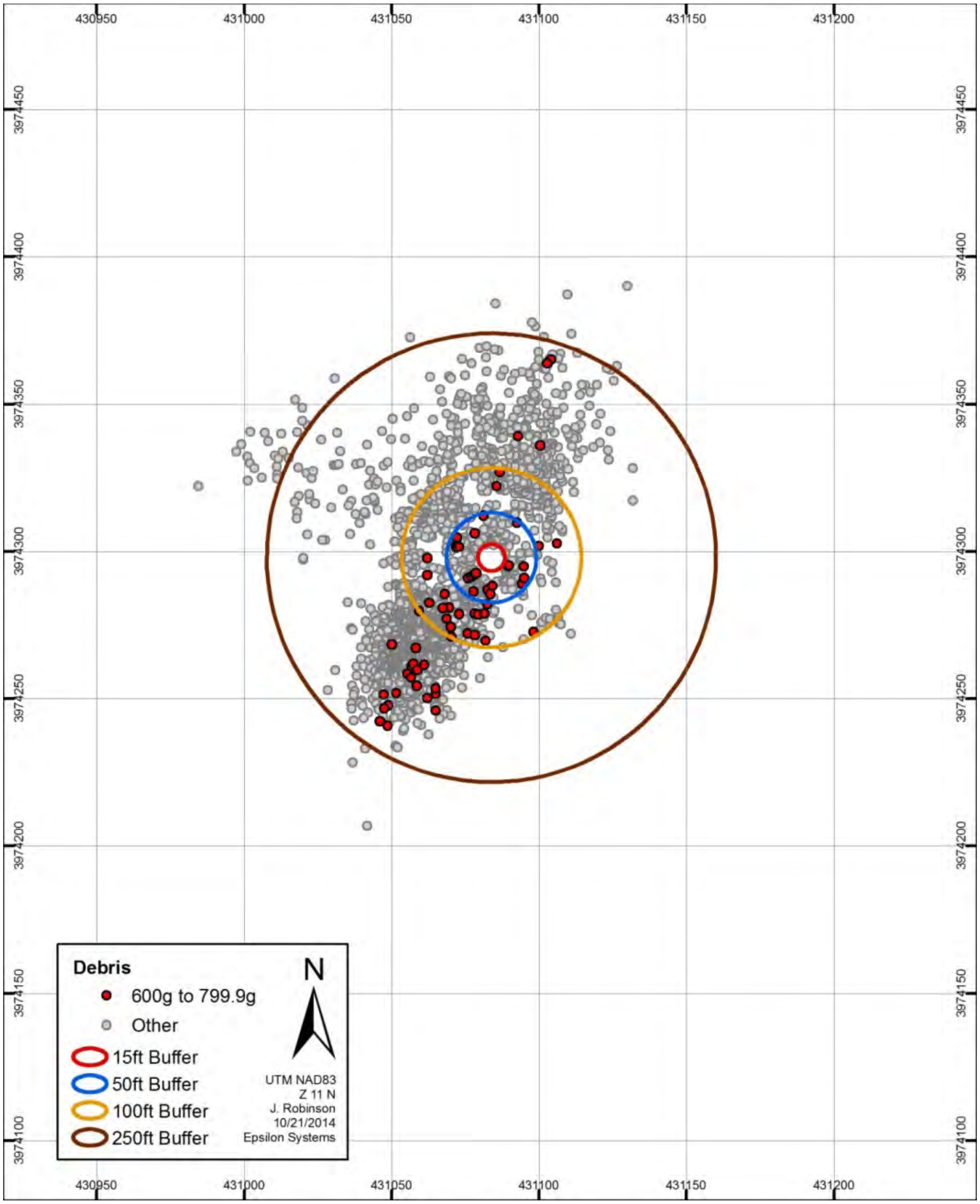

FIGURE III-G-24. Fragment Map of 600- to 799.9-g Fragments (Test 2).

Figure III-G-26 presents the fragment map for 400- to 599.9-g fragments. There are 97 fragments with 92 being black and from the roof, two gray fragments from the north wall at 535 g and 480 g, one yellow and gray fragment indicating that it came from the front and east wall junction at 575 g, one black and gray fragment indicating that it came from the roof-north wall junction, and one piece of rebar. The southernmost fragments were two roof fragments; one at 455 g found 68 m from the center of the structure and one at 521 g found 65 m from the center of the structure. The largest fragment in this

category was 595 g found 64 m to the southwest from the center of the structure. The yellow and gray fragment weighed 575 g and was found 7.6 m from the center to the north of the structure (Figure III-G-27). The black and gray fragment, indicating that it came from the north wall-roof junction, at 470 g and found 8.5 m from the center to the east of the structure, is shown in Figure III-G-28.

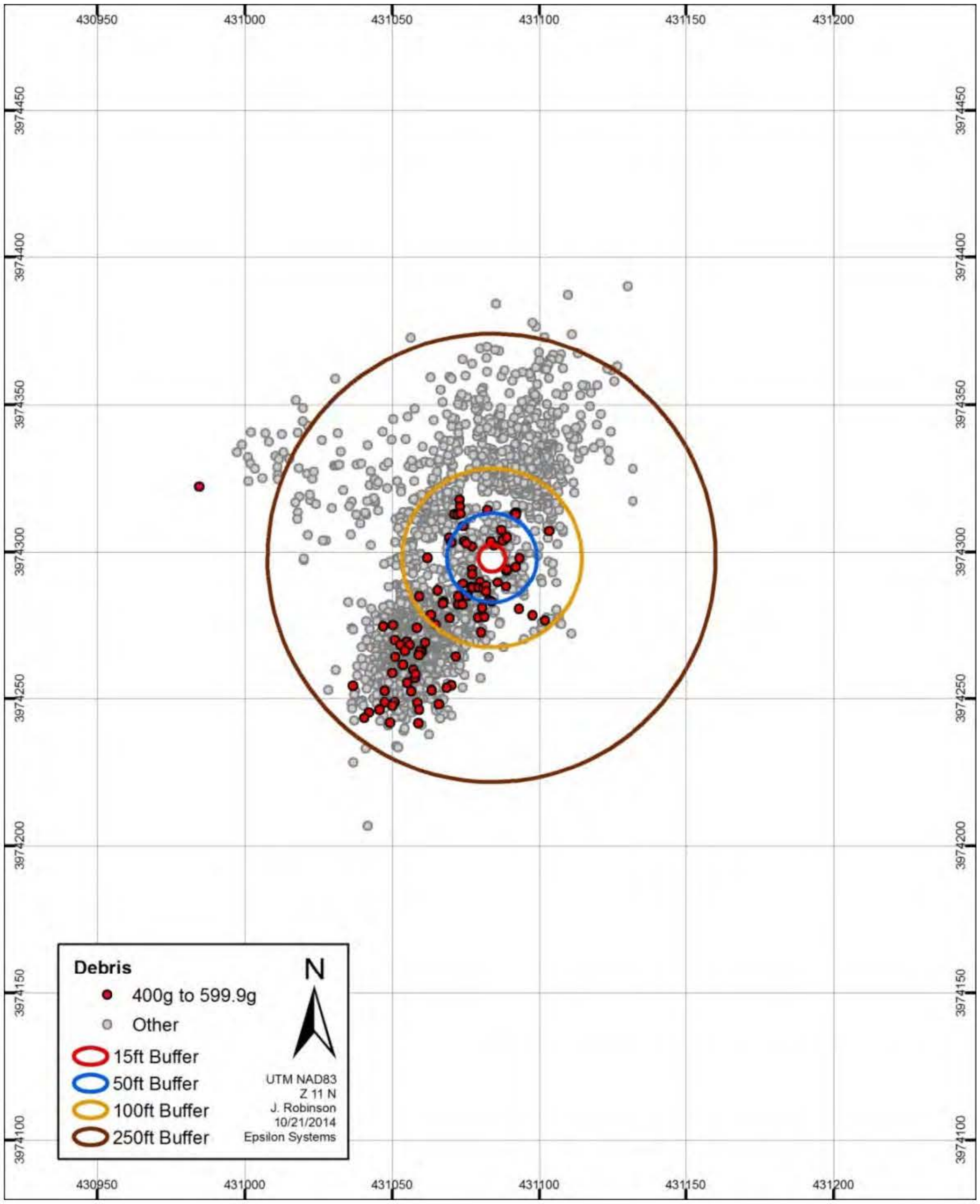

FIGURE III-G-25. Fragment Map of 400- to 599.9-g Fragments (Test 2).

FIGURE III-G-26. Fragment From the East and North Wall Junction (Test 2).
The fragment weight was 575 g and was found
7.6 m northeast from center of structure.

FIGURE III-G-27. Fragment Weighing 470 g From the
Roof-North Wall Junction (Test 2).

Figure III-G-29 presents the fragment map of the 300- to 399.9-g fragments. There are 113 fragments in this category, and all were black concrete indicating that they all came from the roof. The northernmost fragment weighed 303 g and was found 72 m from the center of the structure. The westernmost fragment weighed 362 g and was found 61 m from the center of the structure. The southernmost fragment in this category weighed 360 g and was found 82 m from the center of the structure. The heaviest fragment in this category weighed 398 g and was found 70 m to the southwest from the center of the structure.

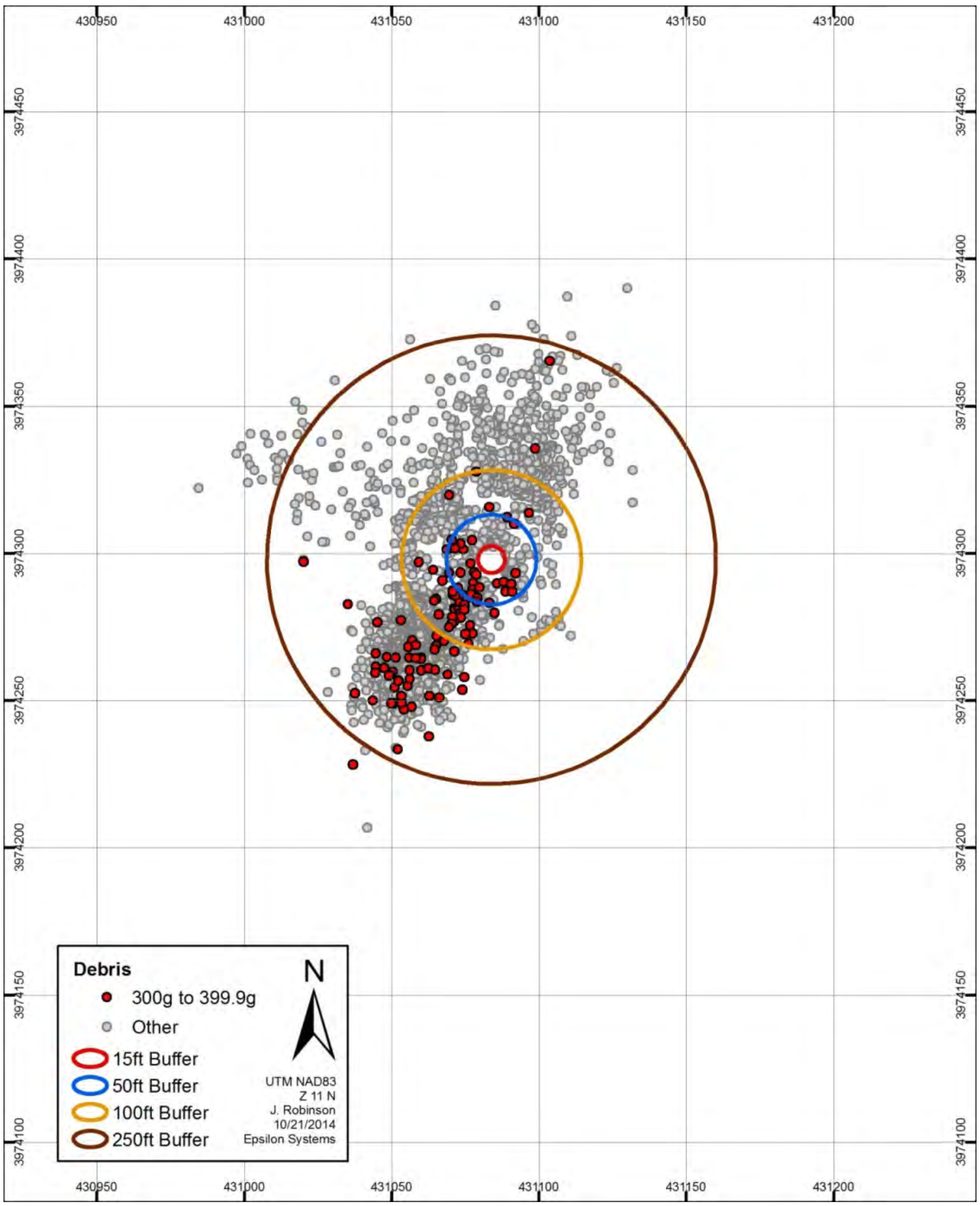

FIGURE III-G-28. Fragment Map of 300- to 399.9-g Fragments (Test 2).

Figure III-G-30 presents the fragment map for the 250- to 299.9-g category. There were 78 fragments in this category with all being from the roof except one that was from the north wall. The northernmost fragment was 279 g and was found 73 m from the center of the structure. The westernmost fragment weighed 267 g and was found 42 m from the center of the structure. The southernmost was also one of the heaviest fragments in this category weighing 295 g and found 43 m from the center of the structure. There were two other fragments that weighed 295 g. One was found 7 m and the other 19 m from the center of the structure.

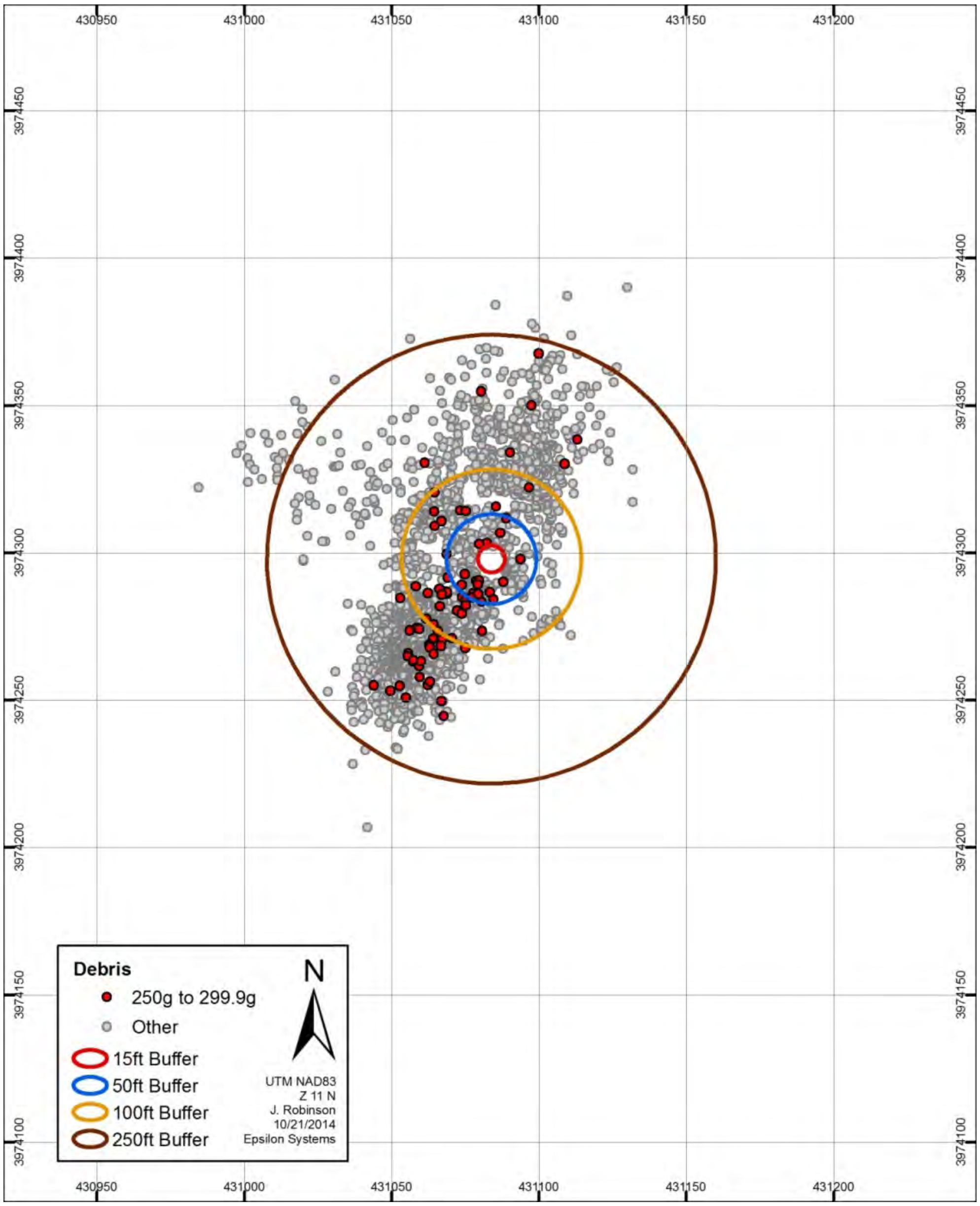

FIGURE III-G-29. Fragment Map of 250- to 299.9-g Fragments (Test 2).

Figure III-G-31 presents the fragment map for 200 to 249.9 g. There are 98 fragments in this category with all being from the roof except one fragment from the front wall that was found 8.5 m from the center of the structure.

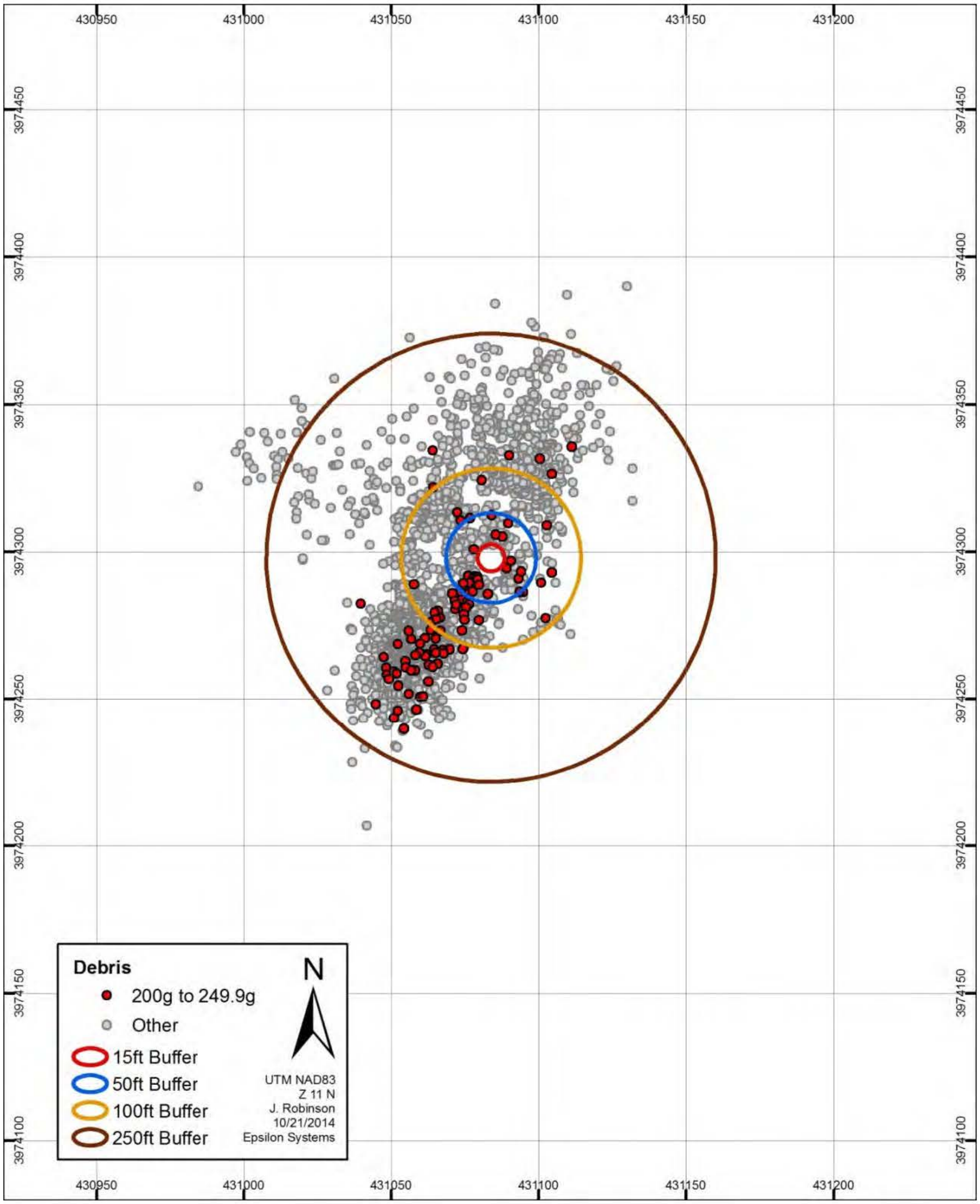

FIGURE III-G-30. Fragment Map of 200- to 249.9-g Fragments (Test 2).

Figure III-G-32 presents the fragment map for the 150- to 199.9-g category. There were 104 fragments in this category, with 100 being fragments from the roof, one green fragment from the west wall that weighed 169 g and was located 50 m toward the

northwest from the center of the structure, and three gray fragments. The gray fragments from the north wall were; 165 g found 9 m northeast of the center of the structure, 152 g located 34 m east-northeast of the center of the structure, and 150 g located 6 m due east of the center of the structure. The north wall fragments found so close to the structure, compared to the roof fragments found much further from the structure, may indicate that the roof failed before the front wall.

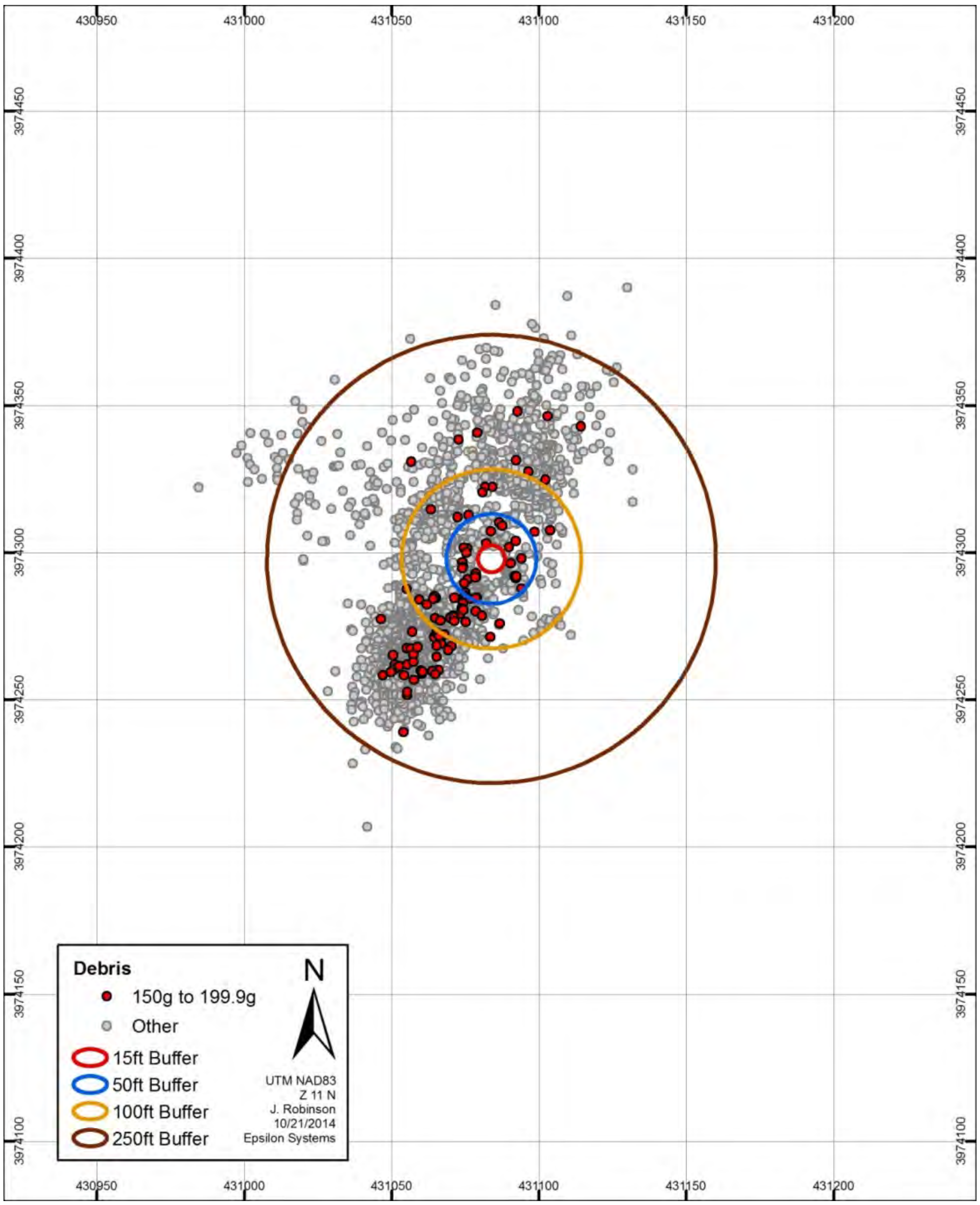

FIGURE III-G-31. Fragment Map of 150- to 199.9-g Fragments (Test 2).

Figure III-G-33 presents the fragment map for 100- to 149.9-g fragments. There were 150 fragments in this category with 147 from the roof, one from the roof front wall joint, and two from the front wall. The first fragment from the front wall weighed 137 g and was found at 28 m north-northeast of the center of the structure, and the second

weighed 115 g and was found at 23.5 m north-northeast from the center. The fragment from the north wall roof joint weighed 100 g and was found at 11 m east of the north wall of the structure. The northernmost fragment was a 103-g roof fragment found 75 m northeast from the center of the structure. The easternmost fragment was from the roof and weighed 140 g. It was found 75 m northeast of the center of the structure. The southernmost fragment was also from the roof and weighed 118 g. The fragment was found 63 m south-southwest of the center of the structure. Another fragment in the southwestern area was a 103-g roof fragment 67 m from the center of the structure.

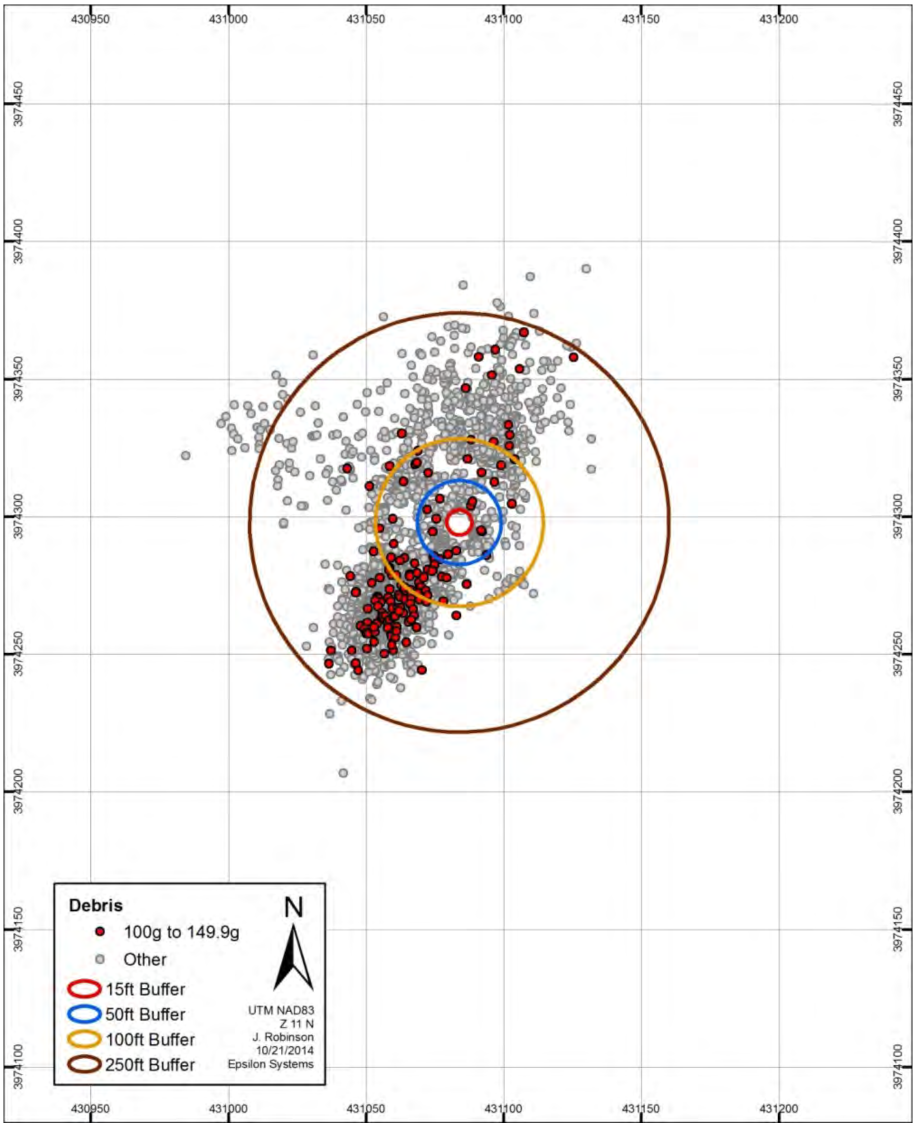

FIGURE III-G-32. Fragment Map of 100- to 149.9-g Fragments (Test 2).

Figure III-G-34 presents the 80- to 99.9-g fragment map. All of the fragments were from the roof. The easternmost fragment weighed 89 g and was located 80 m northeast of the center of the structure. The northernmost fragment weighed 82 g and was 83 m northeast of the center of the structure. The southernmost fragment weighed 91 g and

was located 70 m southwest of the center of the structure. The westernmost fragment was 89 g and was located 69 m from the center of the structure.

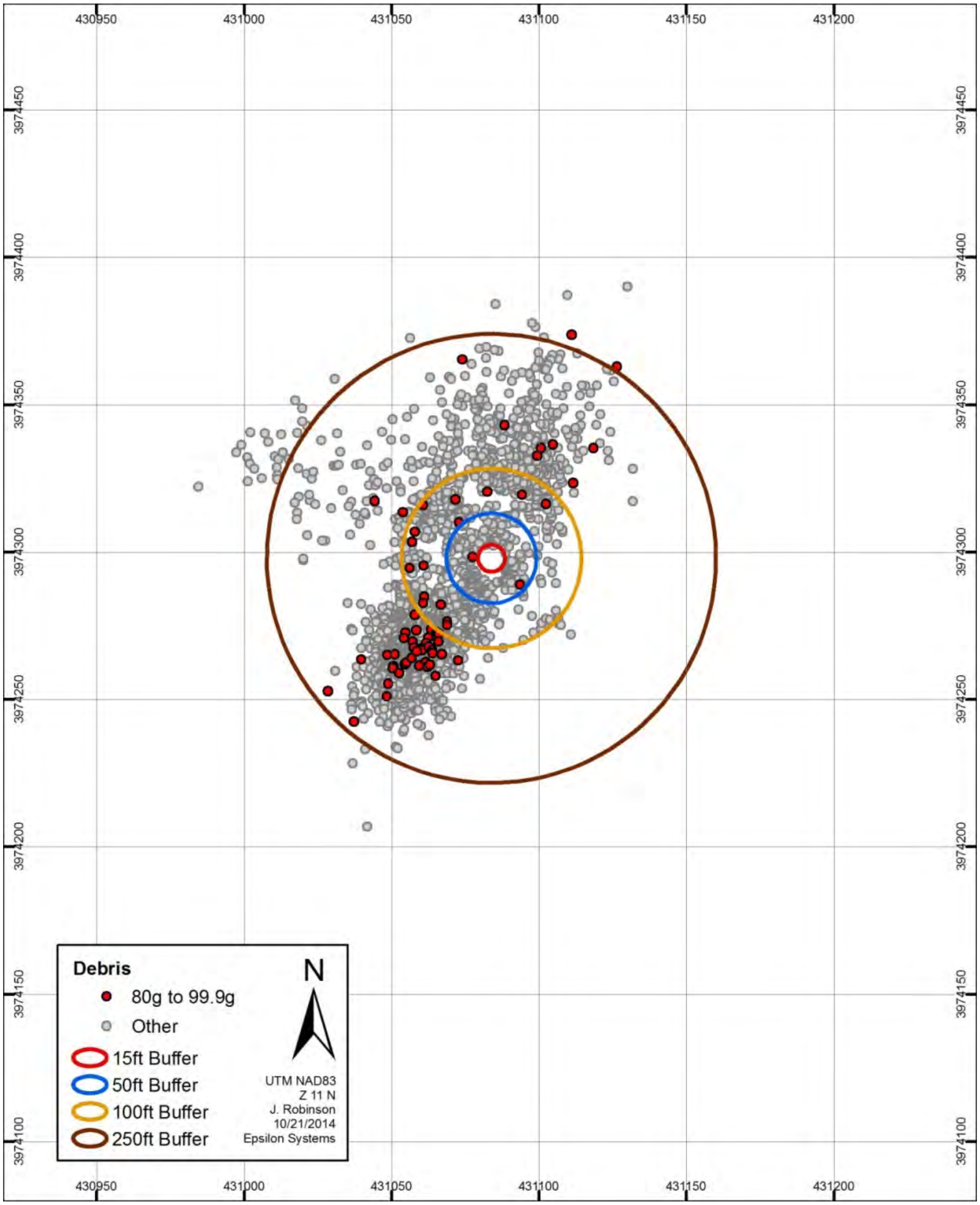

FIGURE III-G-33. Fragment Map of 80- to 99.9-g Fragments (Test 2).

Figure III-G-35 presents the fragment map for the 60- to 79.9-g fragments. The northernmost fragment for this category (and also the northern most fragment overall) weighed 76 g and was located 105 m northeast of the center of the structure. The westernmost fragment weighed 68 g and was located 61 m west of the center of the structure.

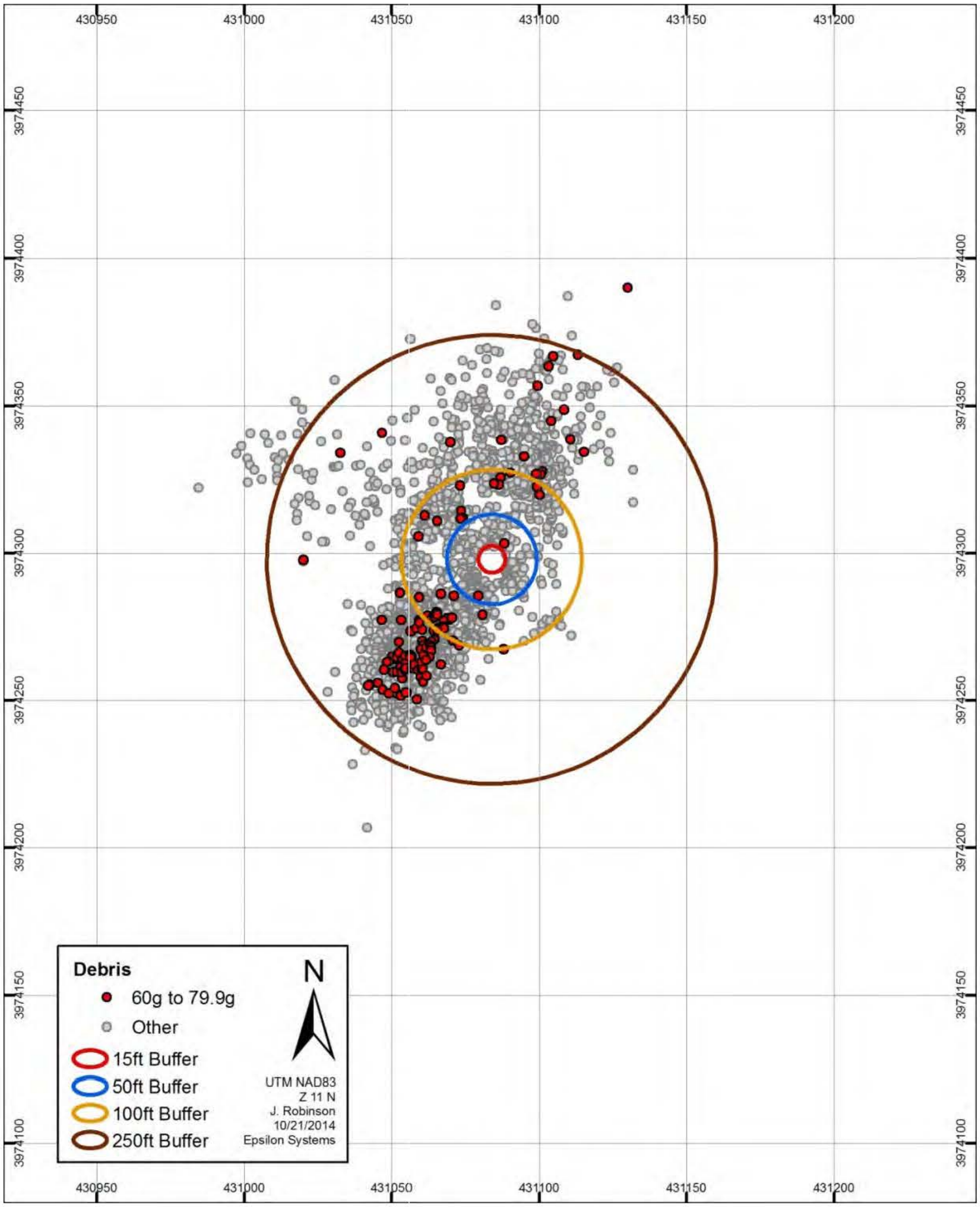

FIGURE III-G-34. Fragment Map of 60- to 79.9-g Fragments (Test 2).

Figure III-G-36 presents the fragment map for the 40- to 59.9-g fragment category. There were 164 fragments in this range, all black indicating that they came from the roof with the exception of 9 fragments from the front wall and one piece of rebar. The gray fragments were all found to the east and north of the center of the structure. They ranged in weight from 55 g (2 fragments) to 41 g and were found between 10 m and 42 m from the center of the structure. The piece of rebar weighed 50 g and was found 19 m to the southwest of the center of the structure.

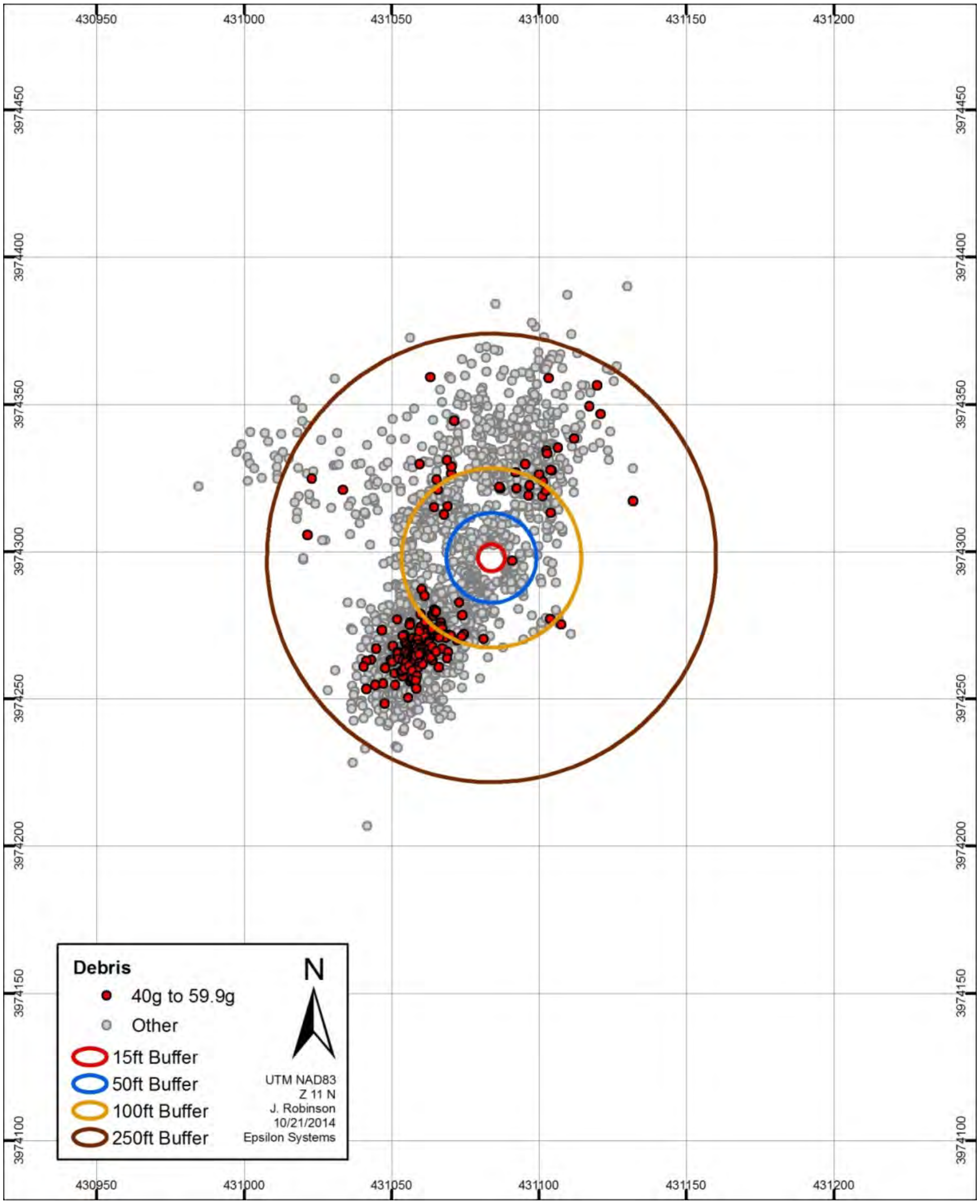

FIGURE III-G-35. Fragment Map of 40- to 59.9-g Fragments (Test 2).

Figure III-G-37 presents the fragment map for the 25- to 39.9-g fragments. There were 235 fragments in this range with all but 8 fragments from the roof. The eight other fragments, ranging from 25 to 36 g, came from the front wall and were found all to the east and north of the center of the structure with the closest being found at 29 m and the furthest found at 44 m from the center.

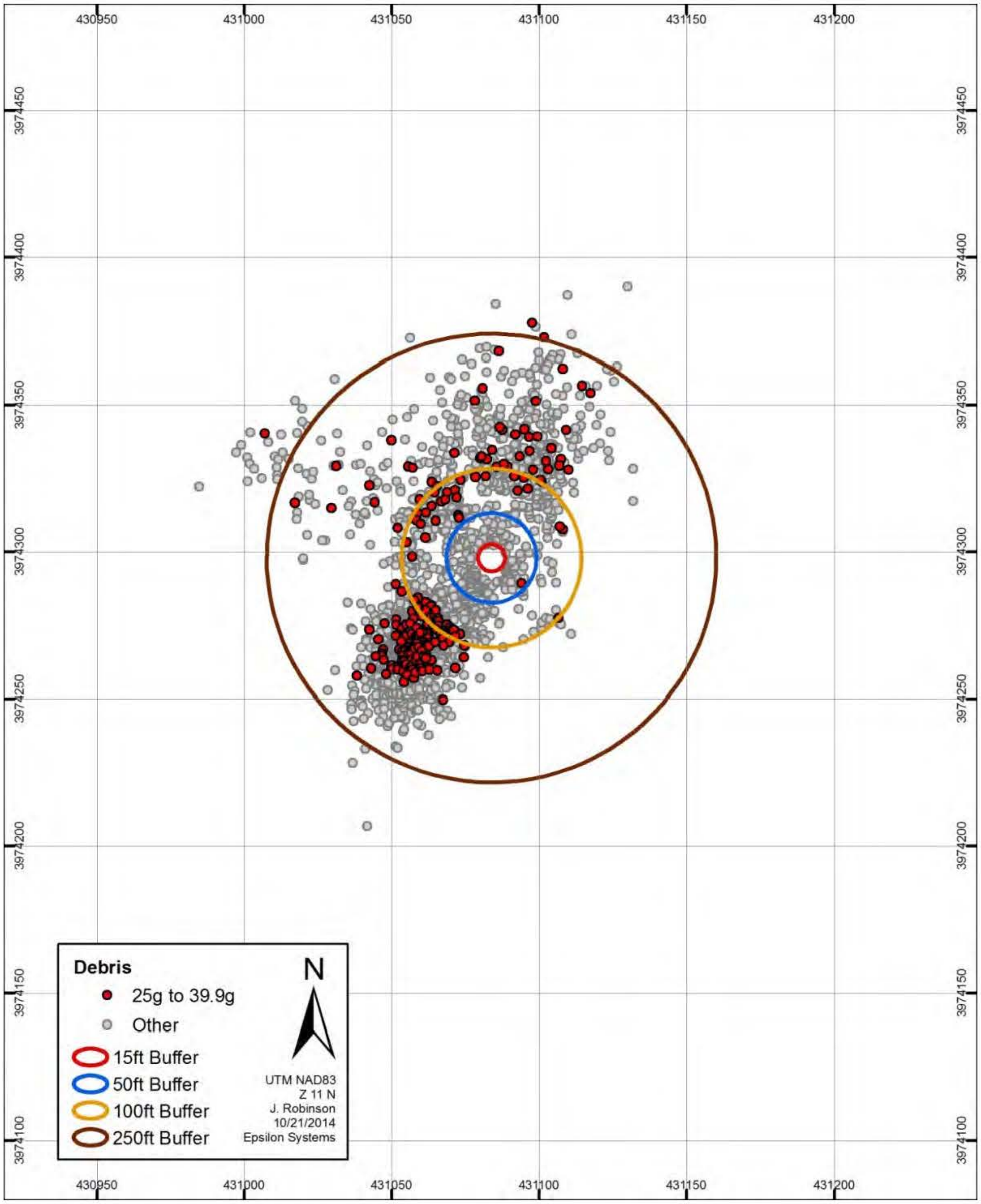

FIGURE III-G-36. Fragment Map of 25<m<39.9-g Fragments (Test 2).

Figure III-G-38 presents the fragment map for 15- to 24.9-g fragments. There were 303 fragments in this range with all but 7 from the roof. The other seven were from the front wall and ranged from 16 to 22 g. Six of the seven were found northeast from the center of the structure with the other fragment found northwest of the center. The fragments were found 26 to 33 m from the center. Of the roof fragments, the northernmost was found about 80 m from the center of the structure, the southernmost at 85 m, and the westernmost approximately 90 m from the center of the structure.

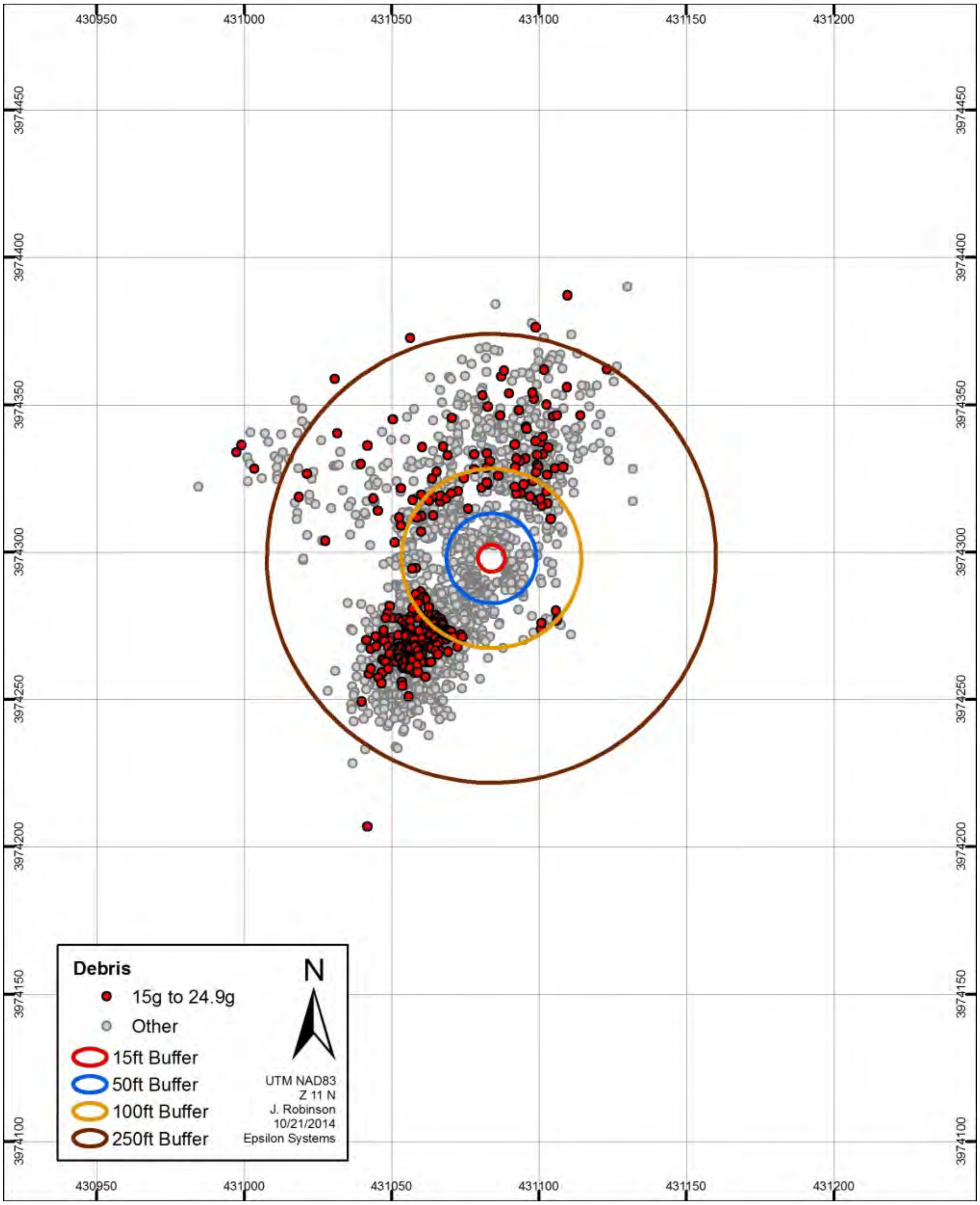

FIGURE III-G-37. Fragment Map of 15- to 24.9-g Fragments (Test 2).

Figure III-G-39 presents the fragment map for the less than 14.9-g fragment range. Note should be taken that there were 57 fragments picked up that were less than 5 g. Almost all fragments were 4 g, but there were a few 3-g fragments. There were 819 fragments in the less than 14.9-g range. All but 21 were fragments from the roof with the 21 fragments being from the north wall. All but two of the north wall fragments were found northeast of the center of the structure with two found on the west. Some of the north-wall fragments traveled as far as 37 to 39 m. The northernmost fragment in Figure III-G-39 was a roof fragment found 75 m from the center of the structure, while the westernmost fragment was a roof fragment at approximately 90 m from the center of the structure.

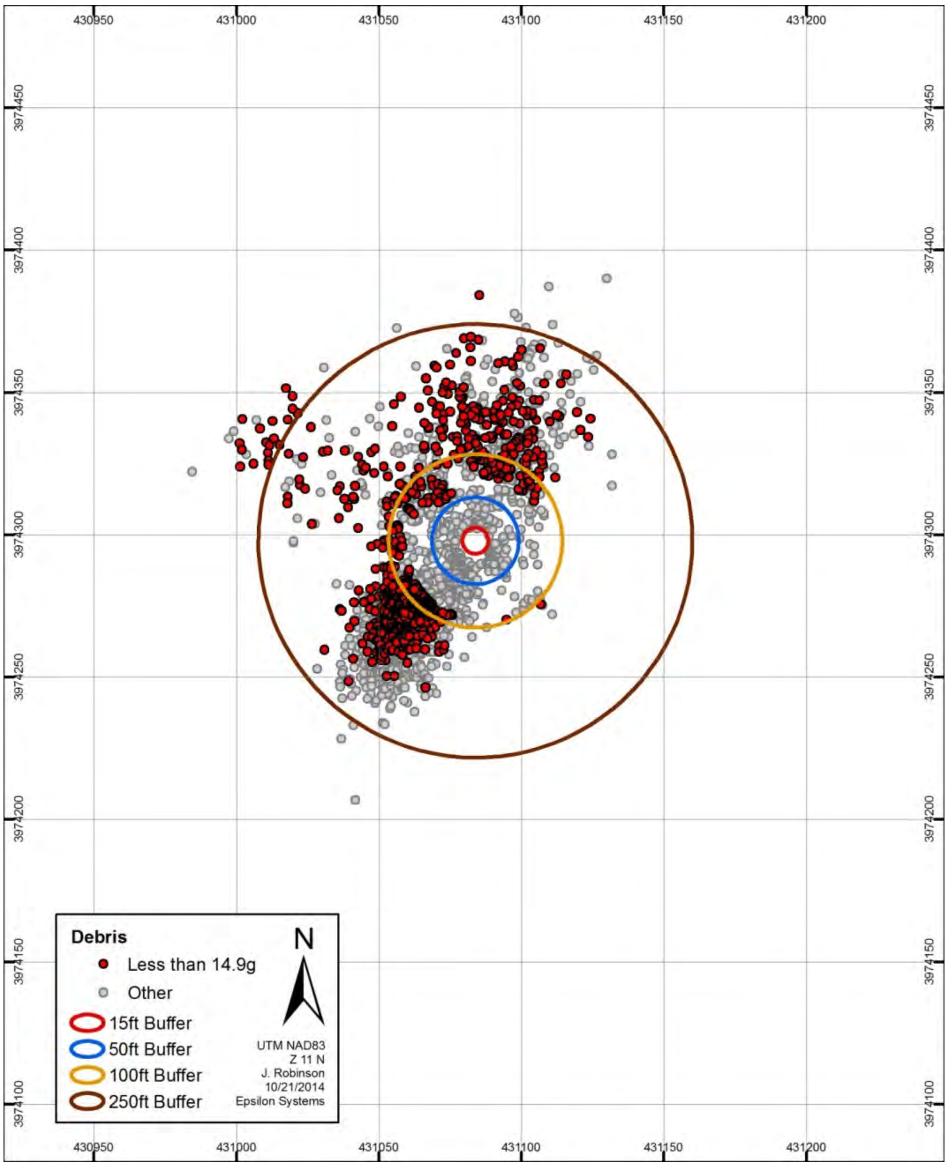

FIGURE III-G-38. Fragment Map of Fragments Recovered Weighing Less Than 14.9-g (Test 2).

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CHAPTER IV. TEST 3—UNCHOKED FLOW WITH THE LARGER M1 GRAIN

TEST CONFIGURATION

Test 3 was conducted on 12 March 2013 at the Airport Lake (dry lake bed) test site at NAWCWD, China Lake, California. The test was similar to that of Test 1 with a 79-cm-diameter closure plate bolted to the front of the structure.

Test 3 had three drums of M1 propellant (Figure IV-1) with a total weight of 264 pounds (120 kg) and a loading density of 15.00 kg/m^3. The bed depth of the propellant in Test 3 was ~11.66 inches from the top of the barrel.

The test configuration was as described in Chapter I. The geometry of the M1 gun propellant in Test 3 differed from Test 1. Test 3 used larger propellant grains with seven small perforations in each grain (7P). The nominal dimensions of the grain were 4.77-mm outer diameter, 10.765-mm length, and 0.451-mm perforation diameters. The propellant samples were obtained from Hawthorne, Nevada, from the demilitarization account.

FIGURE IV-1. Barrels of M1 Propellant in Test 3.

GAGE LOCATIONS

The Test 3 interior gage locations are oriented with the north opening of the structure facing the reader (Figure IV-2).

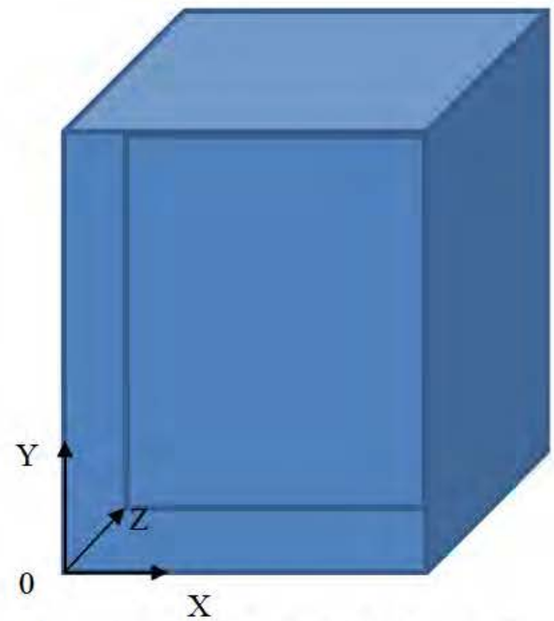

FIGURE IV-2. Reference Figure for Internal Instrumentation.

The inside gage locations are presented in Table IV-1 for Test 3. Outside gage locations are given in Figure IV-3.

TABLE IV-1. Gage Locations Inside Structure for Test 3.

Gage	ID	Location, inches			Comments
		X	Y	Z	
Thermocouple	1	78.72	59.22	61.47	West wall, top, south (top far corner*)
Thermocouple	2	78.72	60.72	19	West wall, top, north (top near corner*)
Thermocouple	3	78.72	56.97	61.47	West wall, bottom, south (bottom far corner*)
Thermocouple	4	78.72	57.97	17.25	West wall, bottom, north (top near corner*)
Thermocouple	5	76.22	70.22	76.22	South wall, top, west (upper right corner*)
Thermocouple	6	76.97	8.75	76.22	South wall, bottom, west (lower right corner*)
Thermocouple	7	39.36	39.36	74.72	Centered on south wall
Thermocouple	8	1.5	69.97	76.22	South wall, top, east (upper left corner*)
Thermocouple	9	2	8.5	75.97	South wall, bottom, east (lower left corner*)
Thermocouple	10	3	69.97	2.75	North wall, top, east (upper left corner*)
Thermocouple	11	1.75	8.5	2	North wall, bottom, east (lower left corner*)
Thermocouple	12	39.25	76.47	8.75	North wall, top, center (above door)
Thermocouple	13	39.97	2	8.75	North wall, bottom, center (below door)
Thermocouple	14	76.22	69.97	2.5	North wall, top, west (upper right corner*)
Thermocouple	15	76.47	8.75	2.75	North wall, bottom, west (lower right corner*)
Thermocouple	16	35	75.72	38.75	Centered on roof
Thermocouple	17	36.5	2.00	39	Centered on floor
Thermocouple	18				On barrel 2
Thermocouple	19				On barrel 1
Thermocouple	20				On barrel 3
DFT	16	0	41.22	40.22	East wall centered
DFT	17	78.72	47.97	35	West wall centered
Pressure	PI-1	75.72	37	29.75	West wall centered
Pressure	PI-2	75.72	37	35	West wall centered - baseline gage
Pressure	PI-3	36.5	39.47	75.72	South wall centered
Pressure	PI-4	3.25	41.22	40.22	East wall centered
Pressure	PI-5	35	75.72	39	Roof centered
Pressure	PI-6	36.5	3	39	Floor centered

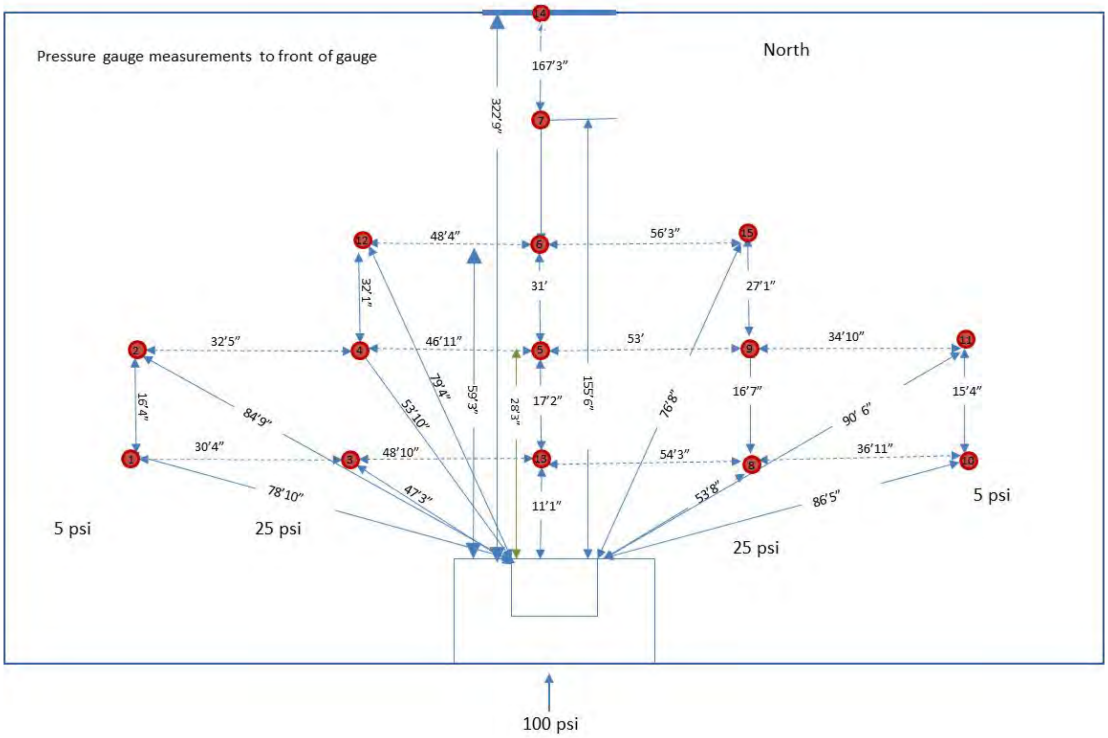

FIGURE IV-3. Outside Gage Locations for Test 3.

TEST RESULTS

The data for Test 3 are similar to Test 1, which is not too surprising, since both were unchoked flow with little pressurization and no structural failure.

INSIDE STRUCTURE

The maximum pressure rise inside the structure was 1.2 psi as seen in Figure IV-4 on gage PI-1 located on the center of the west wall. All of the Test 3 pressure data can be found in Appendix IV-A.

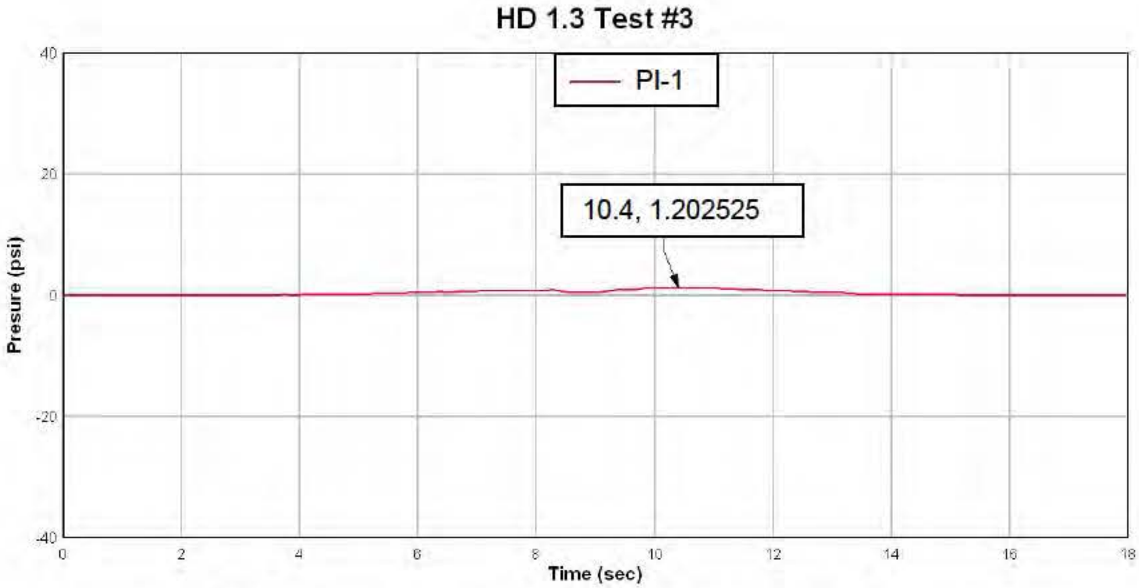

FIGURE IV-4. Maximum Pressure Inside Structure of Test 3.

A maximum temperature of 1118.71°C was measured inside the structure by TC1, located on the west wall near the back of the structure. The maximum temperature inside the structure measured on a barrel was about 829.746°C recorded by TC18. Figure IV-5 shows the trace for TC1, and Figure IV-6 shows the trace for TC18. All of the Test 3 temperature and flux data can be found in Appendix IV-B.

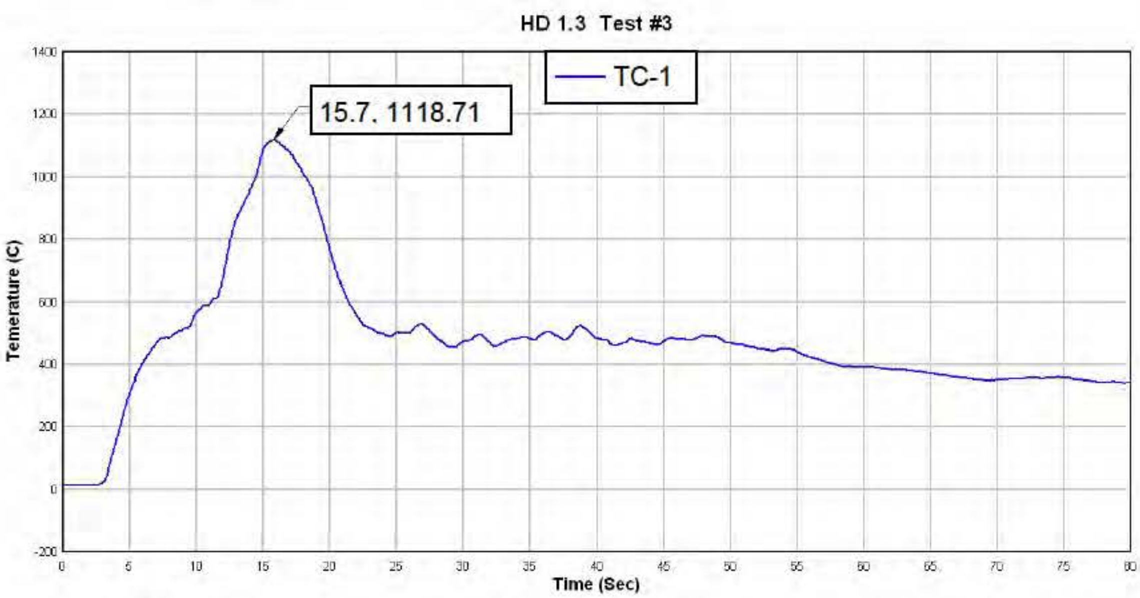

FIGURE IV-5. Maximum Temperature Inside Structure of Test 3.

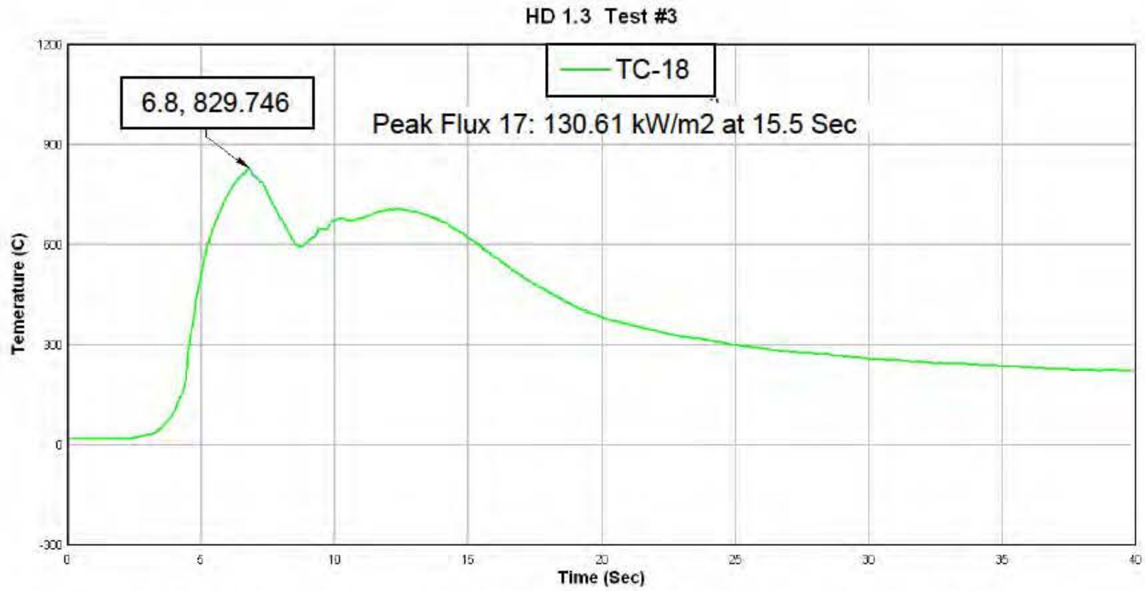

FIGURE IV-6. Maximum Temperature Inside Structure on Barrel 2 for Test 3.

The thermal-flux levels measured inside the structure are plotted in Figure IV-7. A maximum of 171.68 kW/m^2 was measured by the east wall DFT and 130.61 kW/m^2 by the west wall DFT.

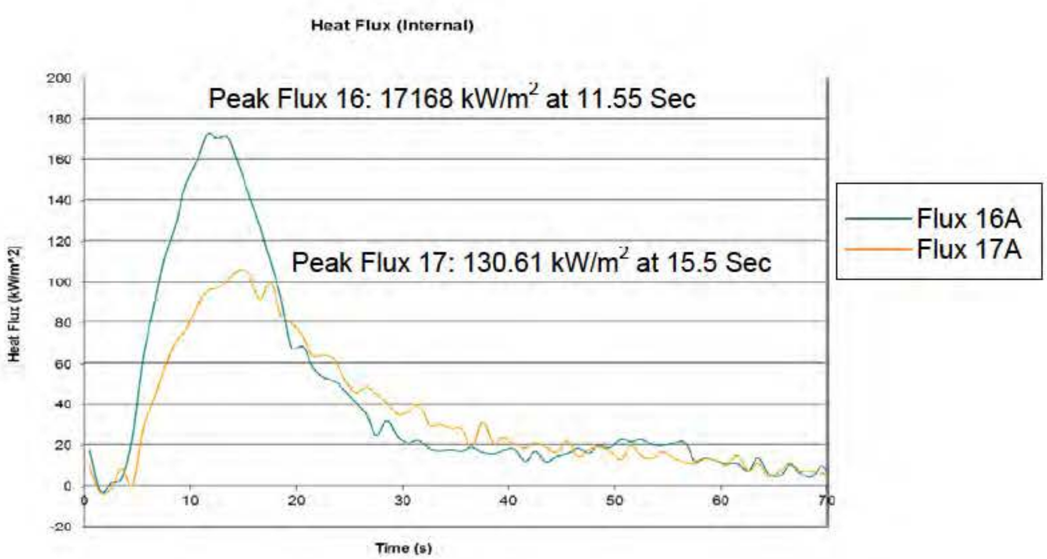

FIGURE IV-7. Thermal Flux Measured Inside the Structure.

There are some slight differences between Tests 1 and 3 due to the difference in grain geometry of the propellants used in the two tests. The main difference was that the smaller grains of Test 1 burned faster and consumed the fiber cylinders of the drums.

The larger grains of Test 3 burned more slowly and did not totally consume the fiber cylinders as can be seen in Figure IV-8.

FIGURE IV-8. Post Test 3 Remains of Fiber Drums.

OUTSIDE STRUCTURE

All of the outside pressure gages reported less than 1 psi maximum pressure. Gage PO-5 reported a pressure of 0.40 at 4.8 seconds before the gage was compromised by the thermal effects of the plume.

Figures IV-9 and IV-10 present the peak heat flux measurements (DFT 13 and 5, respectively) taken external to the structure. These gages were located in direct plume impingement at about 15 and 32 feet from the open face of the structure. A peak thermal-flux measurement of 15,027.93 kW/m^2 was made on gage 13 at 13.5 seconds and at 4,955.89.96 kW/m^2 on gage 5 at 9.5 seconds.

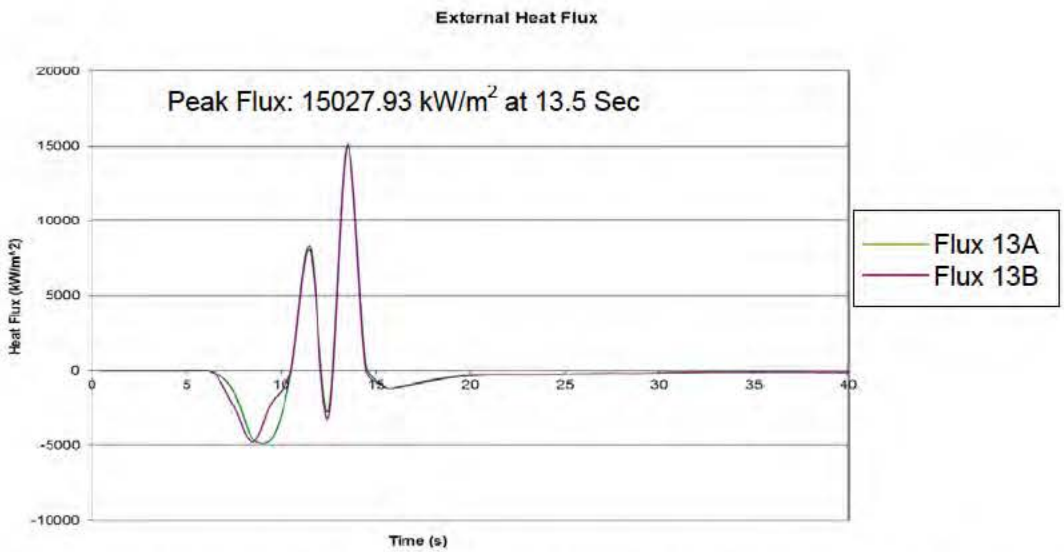

FIGURE IV-9. Heat Flux Recorded by External Heat Flux Gage 13 (Test 3).

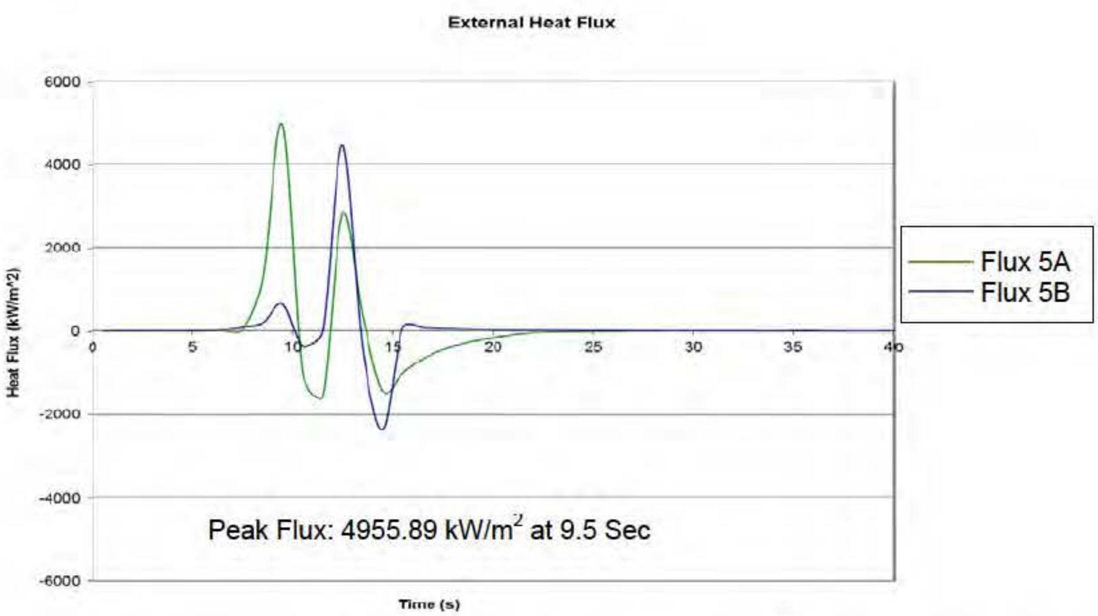

FIGURE IV-10. Heat Flux Recorded by External Heat Flux Gage 5 (Test 3).

Figures IV-11 and IV-12 present heat flux data for gages 10 and 9. These gages were outside direct plume impingement. A peak flux of 11.66 kW/m^2 was recorded at gage 10 at 8.5 seconds (Figure IV-11) located at a distance of about 11 feet from the north-facing orifice of the structure and east of the center line by 91 feet, 2 inches. The negative flux is indicative of a shift in the thermal directionality.

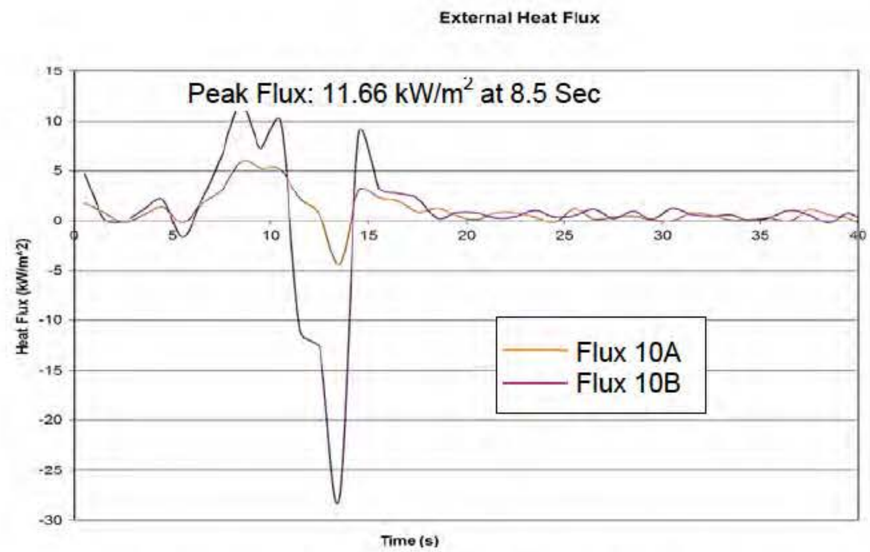

FIGURE IV-11. Heat Flux Data Gage 10 (Test 3).

Heat flux gage 9, located about 32 feet north and 53 feet east of the structure centerline, reported a peak thermal flux of 29.07 kW/m^2 at 8.5 seconds as seen in Figure IV-12.

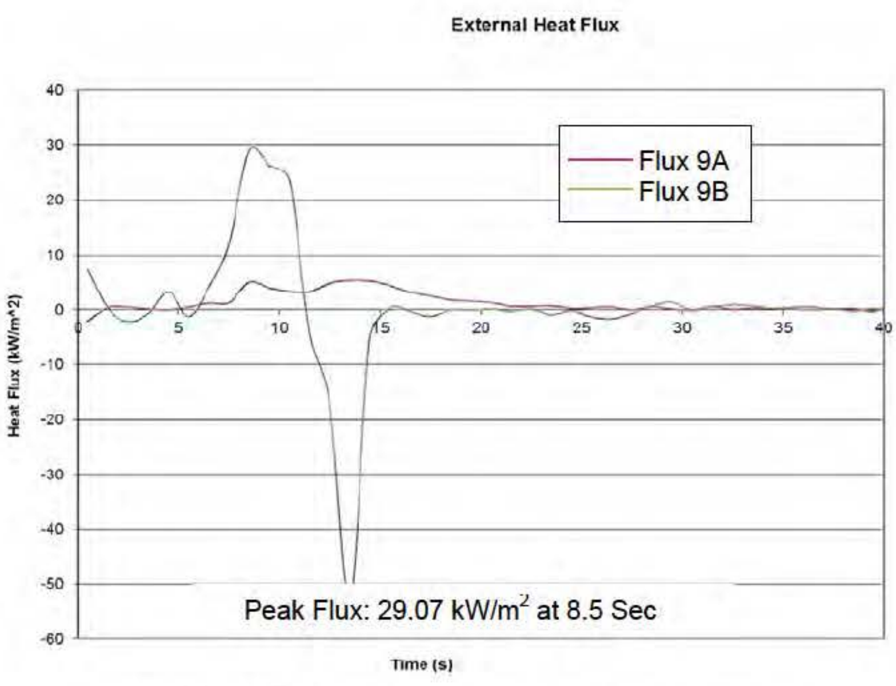

FIGURE IV-12. Heat Flux Data Gage 9 (Test 3).

Figure IV-13 presents a photograph taken of the structure and the plume out of the orifice.

FIGURE IV-13. Structure and Plume-Out Orifice (Test 3).

Figure IV-14 shows the structure and plume shortly after Figure IV-13. At the left-hand side of the plume, a lid from one of the drums can be seen. It is not uncommon for unchoked flow to entrain materials from the interior of the structure. In many instances, the material entrained is unburned propellant that then burns outside the structure.

FIGURE IV-14. Structure and Plume of Test 3. At the left-hand side of the plume, a lid from one of the barrels can be seen.

Figure IV-15 shows the landing spot of the drum lid shown in Figure IV-14.

FIGURE IV-15. Location of Drum Lid Following Test 3.

Figure IV-16 presents the path of the plume from the orifice plate on structure.

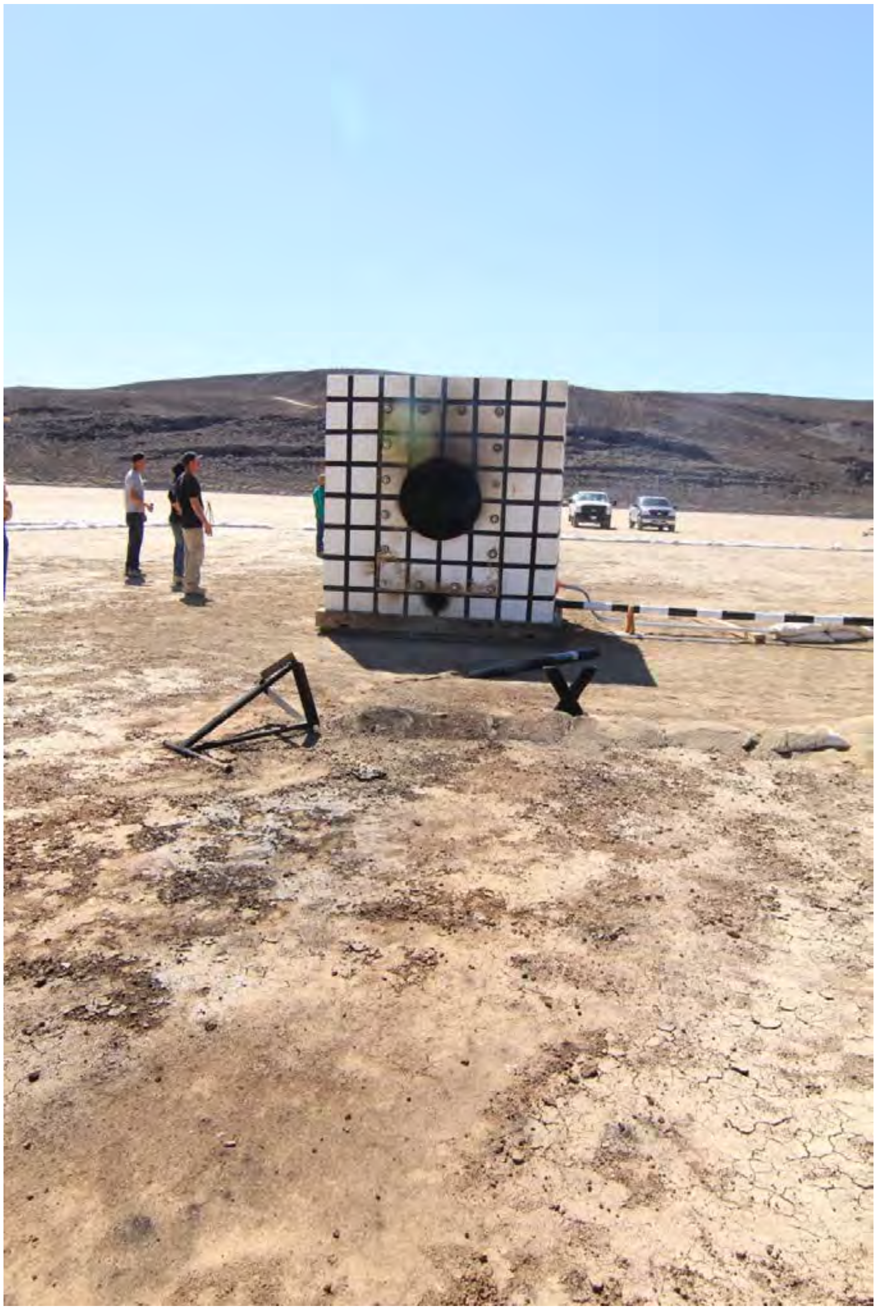

FIGURE IV-16. Path of Plume (Test 3).

Figures IV-17 through IV-19 present still pictures taken from the video of Test 3. The plume exiting the structure is well developed at 6 seconds in Figure IV-18.

FIGURE IV-17. Still Picture Taken From Video of
Test 3 Taken at 2 Seconds After Ignition.

FIGURE IV-18. Still Picture Taken From Video
of Test 3 at 6 Seconds After Ignition.

FIGURE IV-19. Still Picture Taken From Video
of Test 3 at 13 Seconds After Ignition.

DOPPLER AND IR DATA

Doppler data was not collected for this shot due to conflicts in scheduling. High-speed, black and white IR cameras were used to document the intensity of the plume. Figure IV-20 is a still frame of the intensity of the plume at its peak. Figure IV-21 is a frame from a data file that correlates the IR video with the thermal traces instrumentation within and external to the structure. This specific clip is at ~8.5 seconds. Thermocouple 1 (inside the structure) continues to slowly climb in temperature while the temperature from flux gage 5 spikes as the plume engulfs the external gages (13, 5, 6, 7, 8, and 14). The video for the IR data and the correlation of the IR data with the Thermocouple 1 and heat flux temperatures from flux gage 5 are located in Appendixes IV-C and IV-D.

FIGURE IV-20. Plume Intensity From IR Footage.

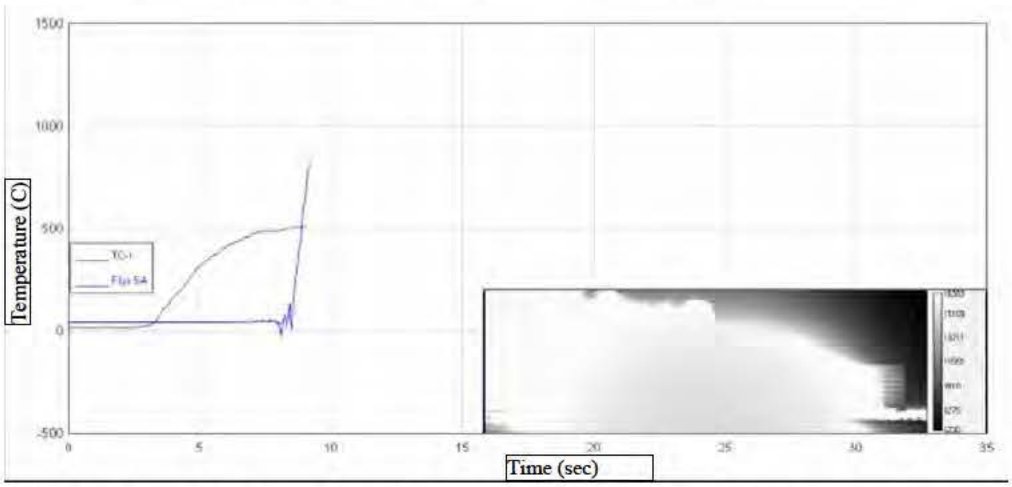

FIGURE IV-21. Plume Intensity From IR Footage Correlated With TC 1 and Heat Flux Temperature From Flux Gage 5.

Thermal hazard is clearly the dominant threat in the unchoked test condition. The direct thermal threat is enhanced by the potential for a secondary fire outside the structure with the ejection of fire brands and entrained objects.

TEST 3 CONCLUSIONS AND RECOMMENDATIONS

Test 3 was the third of a series of tests designed to examine the effect of an HD1.3 energetic material burning in a concrete structure. M1 propellant was the test sample. Test 3 was performed with a larger propellant grain geometry (with seven perforations) and resulted in burn through of the fiber barrels without complete consumption of the barrels. Test 3 was performed with a 79-cm-diameter orifice in the face plate of the structure, resulting in a vent area ratio of 0.1225. The large vent area and relatively low propellant loading density (0015 g/cc) resulted in an unchoked venting condition and no structural failure.

The hazards from the pressure of the unchoked flow are insignificant; peak pressures of 1.2 psi were observed within the structure and less than 1 psi was observed outside the structure.

The velocity of the plume could not be determined for this test, but the IR data provides an intensity level for the plume. The peak intensity measured was 16,383 before the camera was washed out.

Thermal-flux data outside the area of plume impingement was measured at a maximum of 11.66. kW/m^2. The results of Test 3 begin to improve the resolution on prediction the hazards associated with items classified as hazard division (HD) 1.3 mass fire.

IR and high-speed video cameras provided visual details of the plume that were used to measure a plume length in excess of 67 feet. The camera view angle was too narrow to capture the entire plume length in this test. The high-speed and IR video can be observed in Appendix IV-D. The 155.6-foot length of the fireball/plume exceeds the calculated (using Reference IV-1) IBD (75 feet). The measurements are based on the heat flux data and the high-speed video. Heat flux measurements (5.12 kW/m^2) were documented at 322.9 feet, where a person would have approximately 18 seconds before receiving second degree burns. More data should be collected to better predict the thermal hazards of an incident in which HD1.3 energetics are ignited in storage condition where unchoked flow can be observed.

REFERENCES

IV-1. Office of the Deputy Under Secretary of Defense (Installations and Environment). *DOD Ammunition and Explosives Safety Standards.* Washington, D.C., USD(I&E), 29 February 2008. Administratively Reissued 4 August 2010. (DODM 6055.09-M, Volume 1, Enclosures 8 and 9; publication UNCLASSIFIED.)

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Appendix IV-A

HD1.3 TEST 3. PRESSURE DATA

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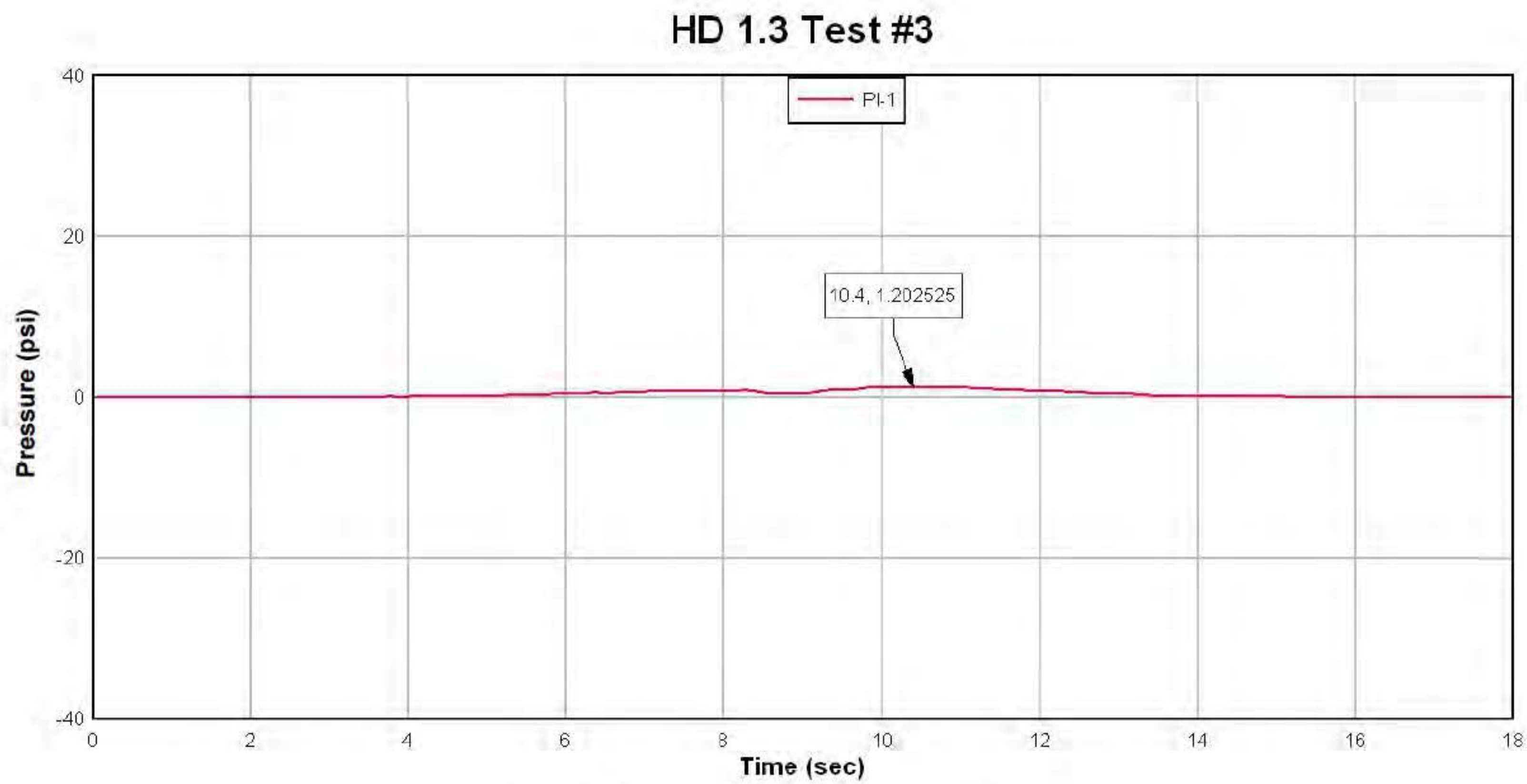

FIGURE IV-A-1. Internal Pressure Gage #1.

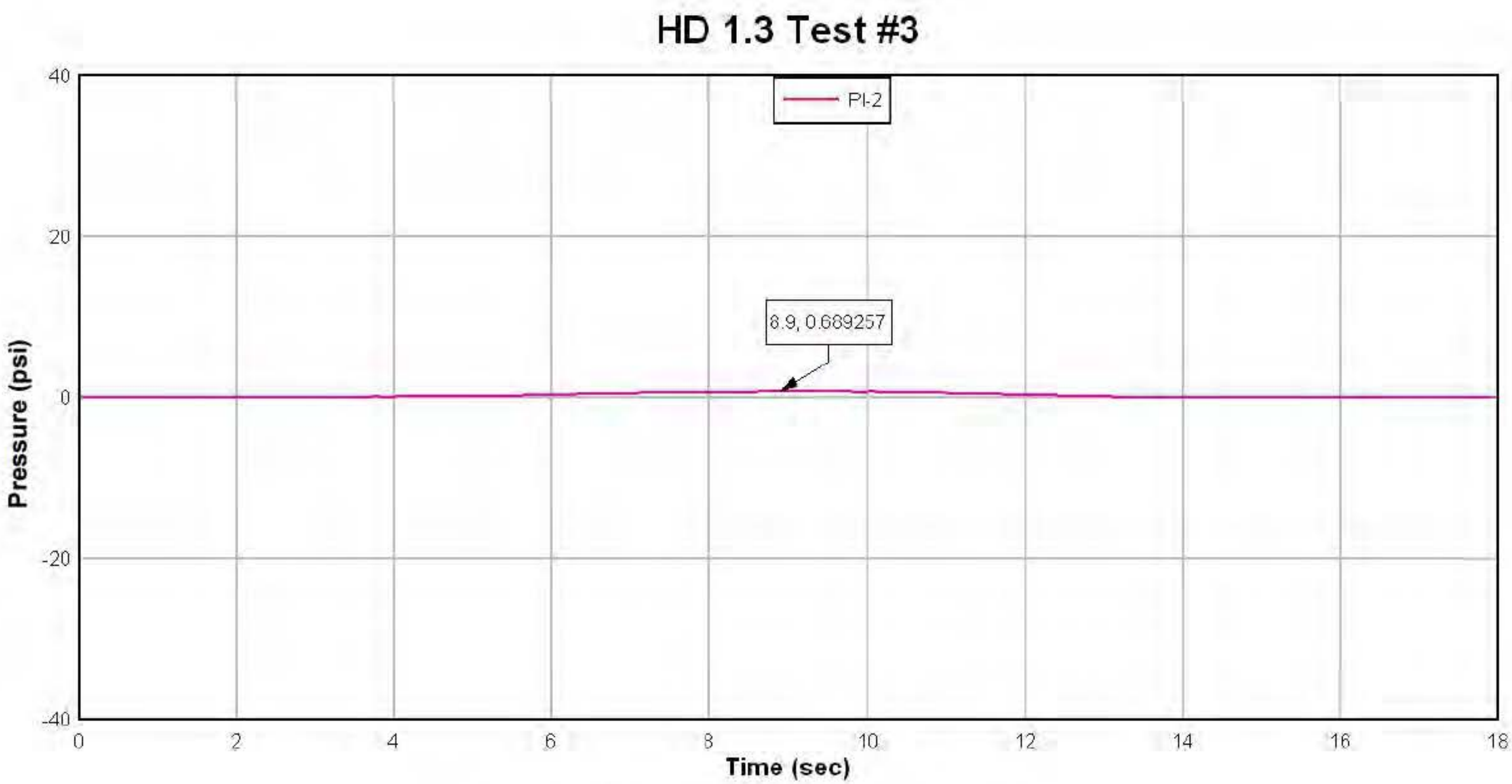

FIGURE IV-A-2. Internal Pressure Gage #2.

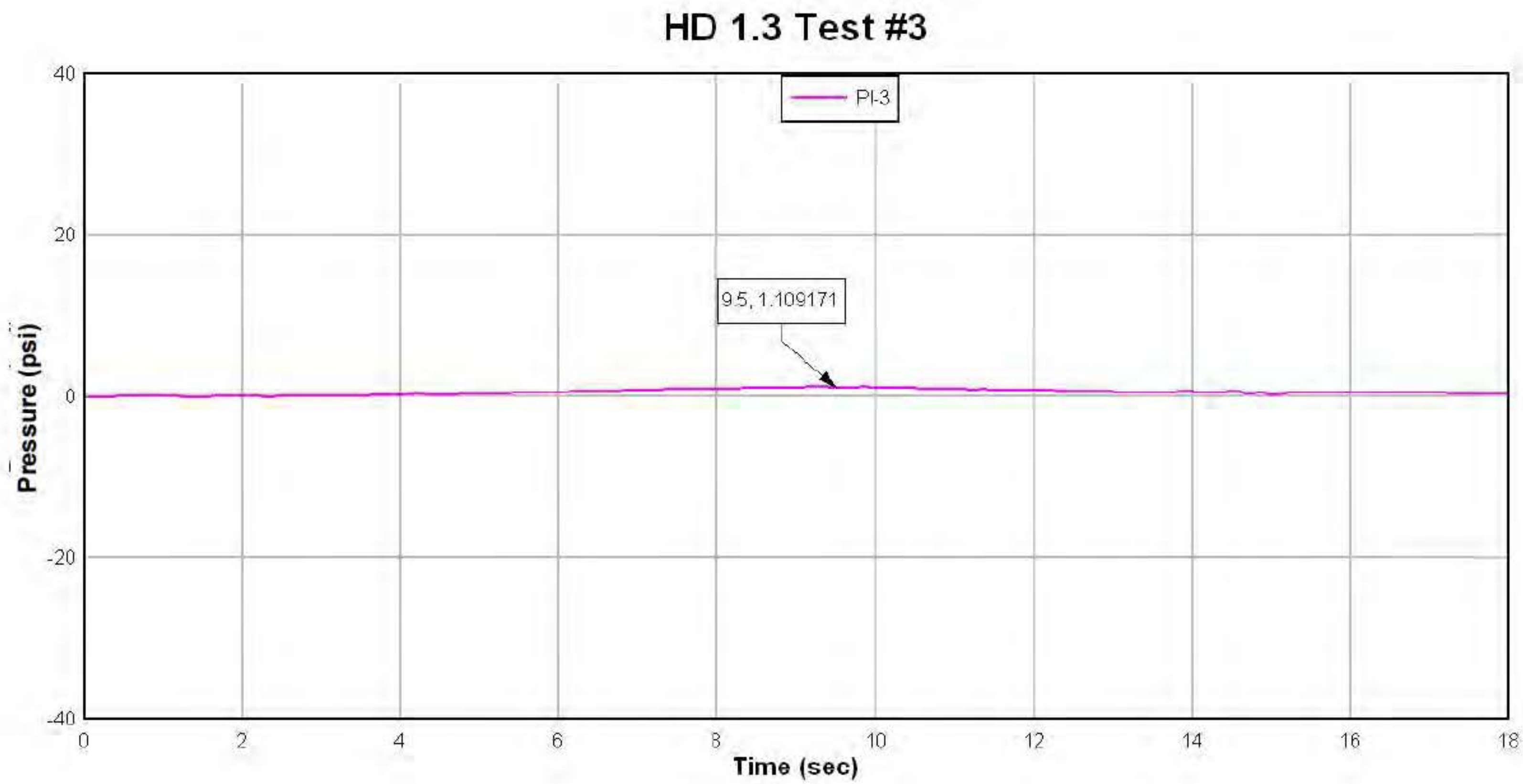

FIGURE IV-A-3. Internal Pressure Gage #3.

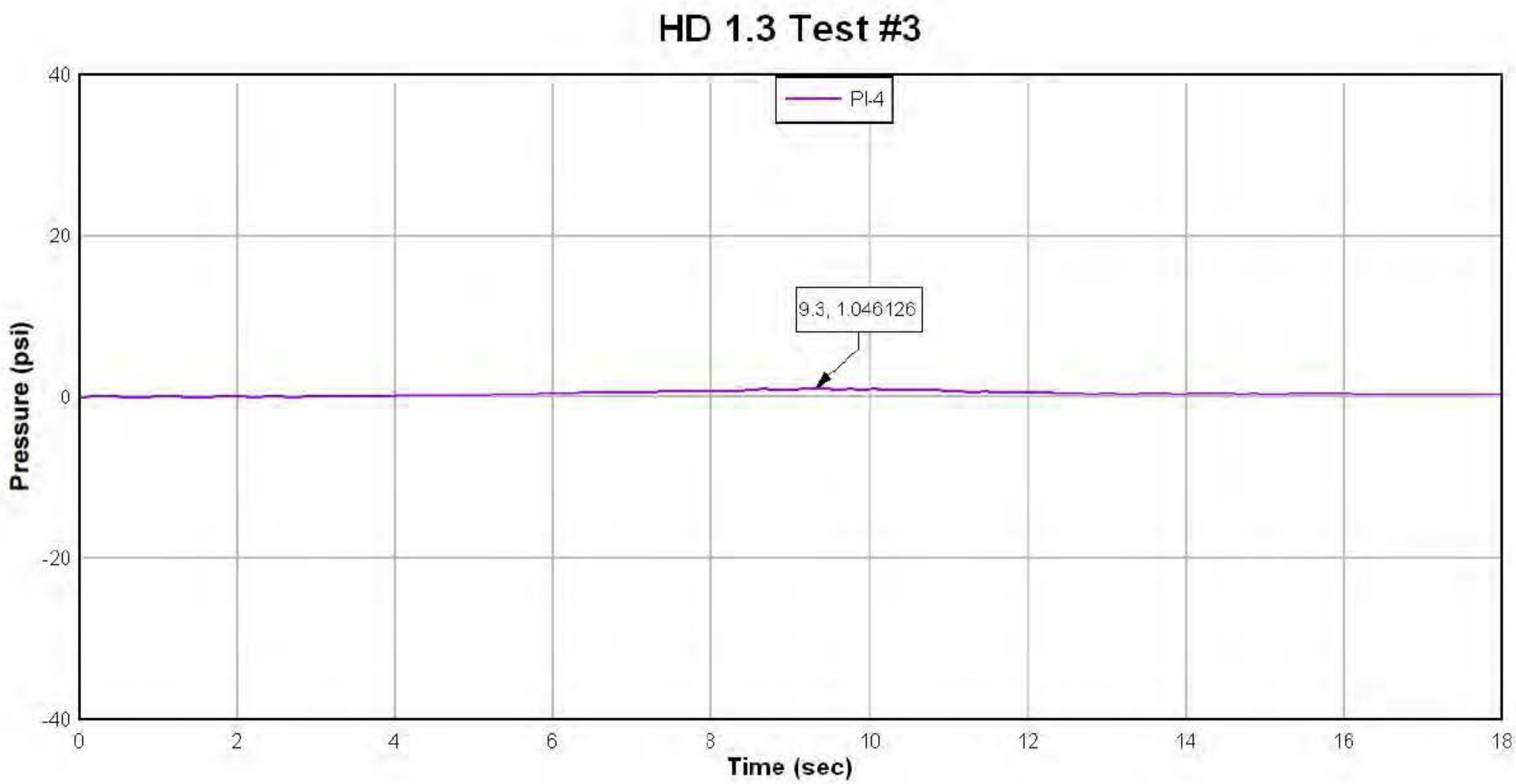

FIGURE IV-A-4. Internal Pressure Gage #4.

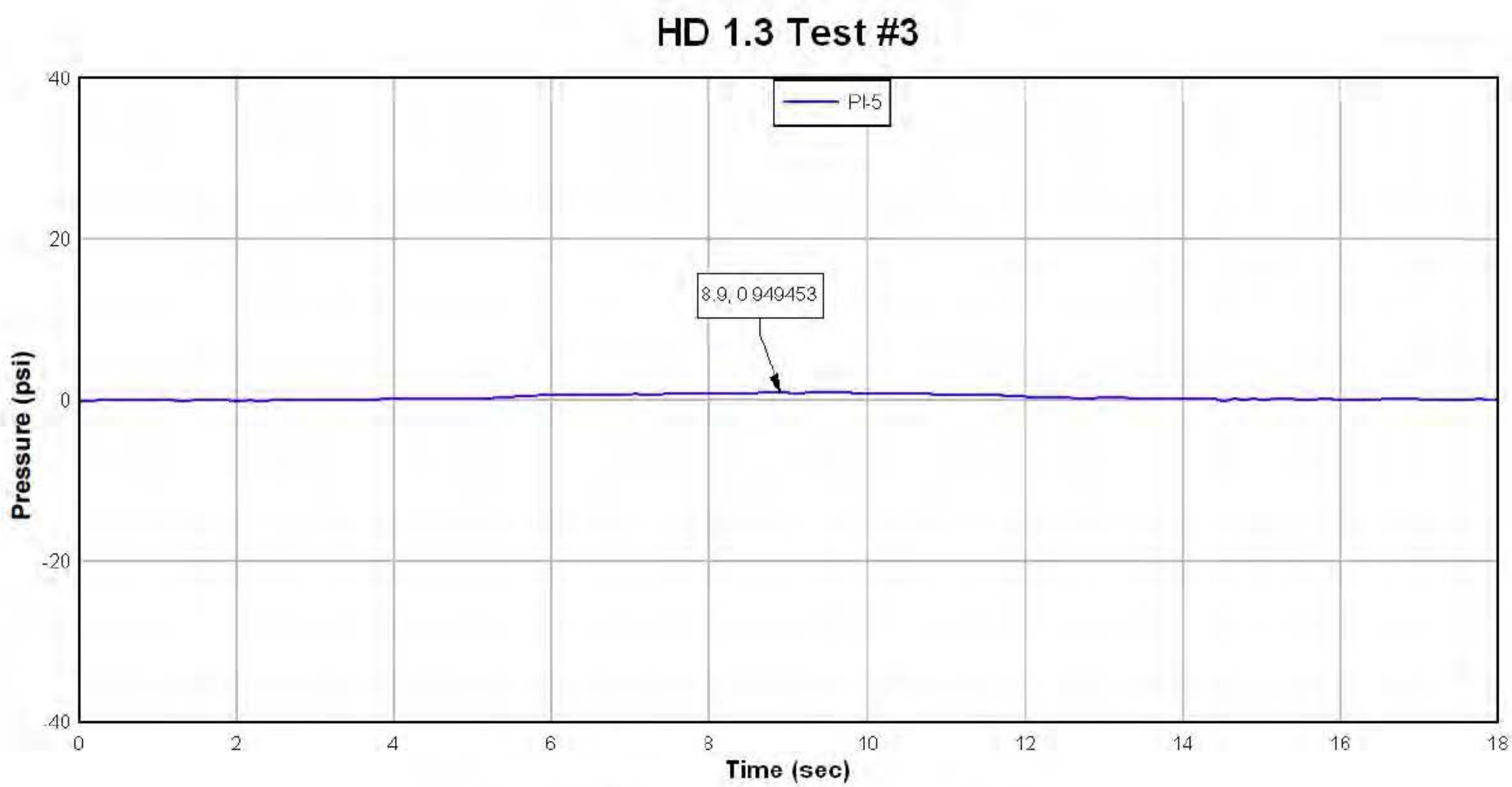

FIGURE IV-A-5. Internal Pressure Gage #5.

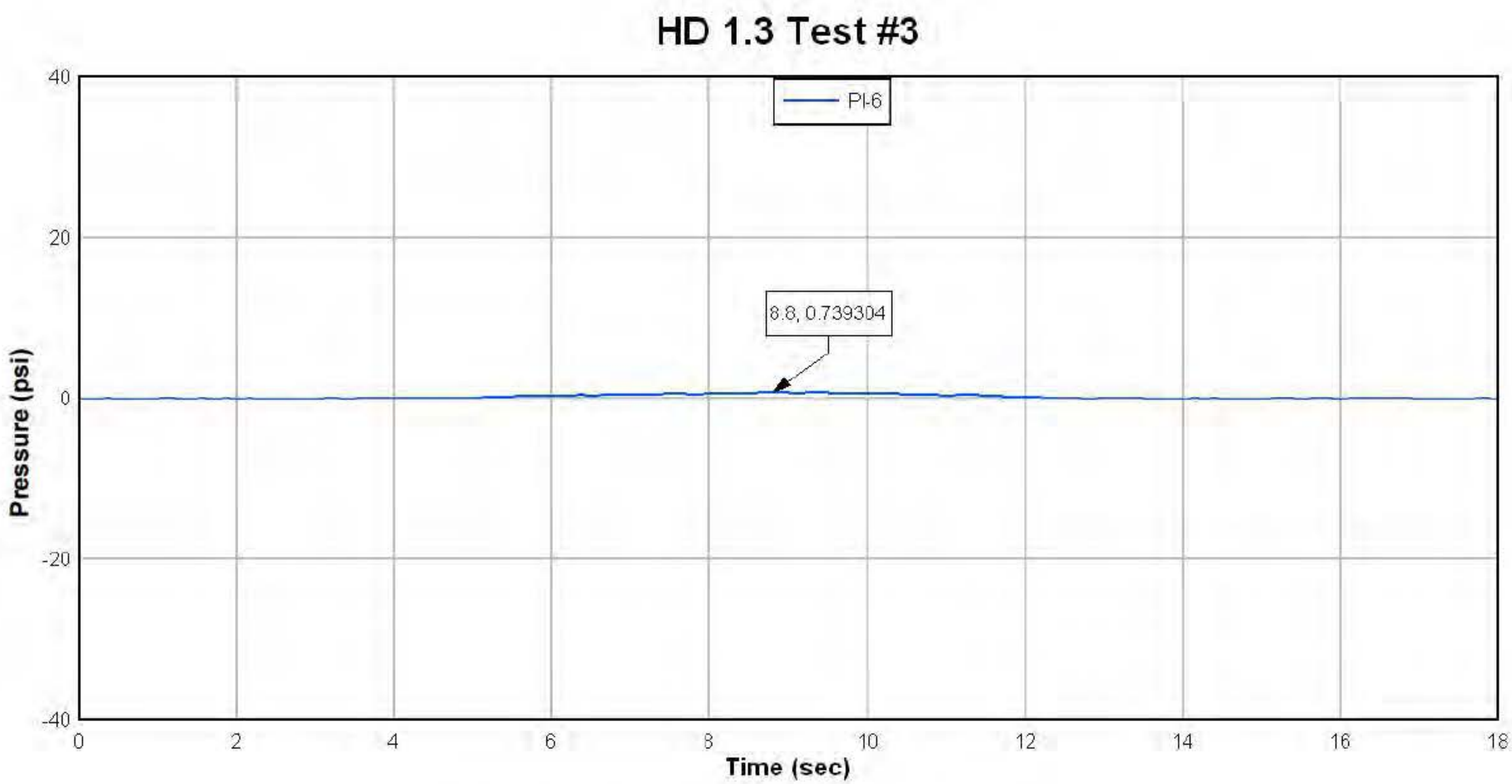

FIGURE IV-A-6. Internal Pressure Gage #6.

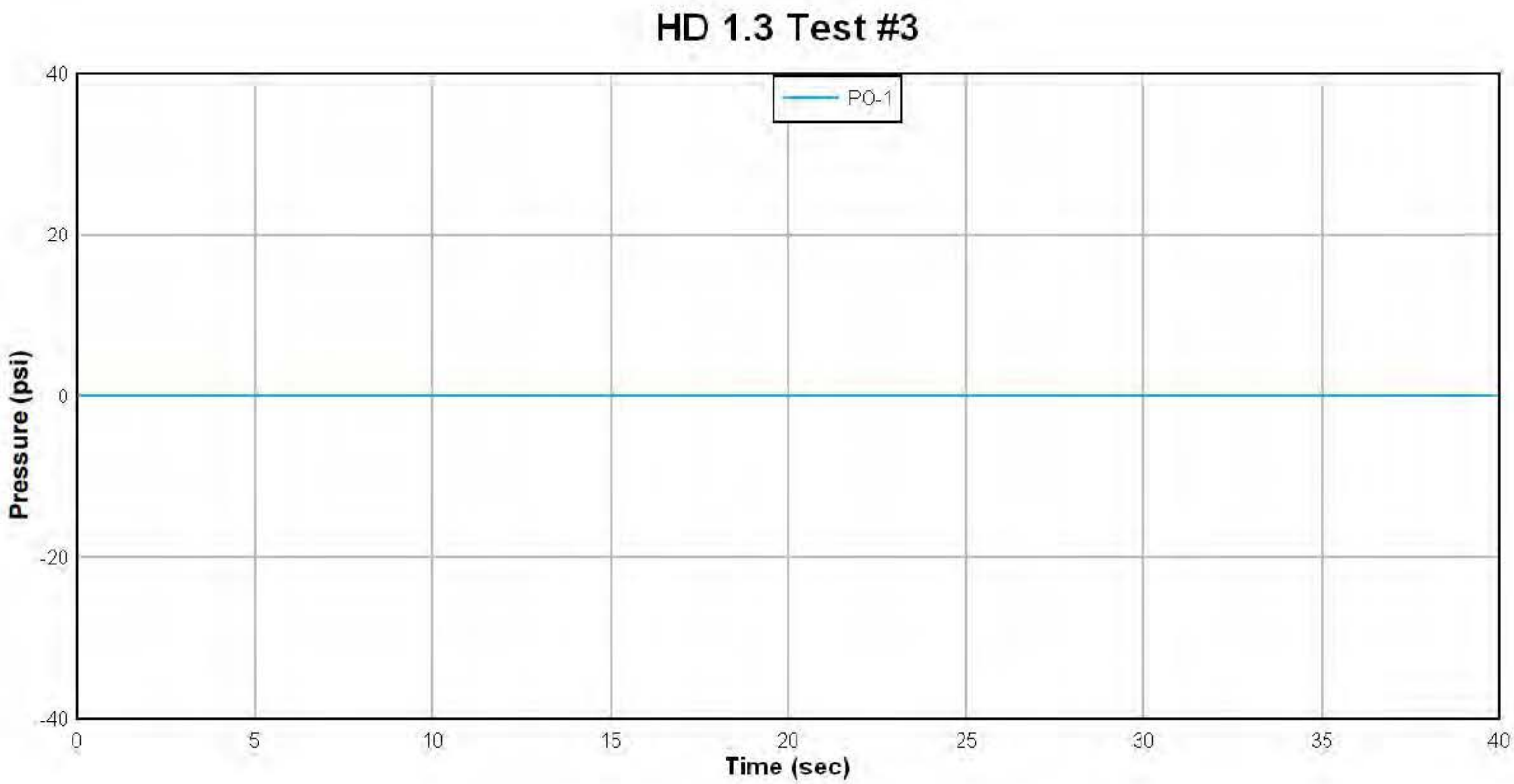

FIGURE IV-A-7. External Pressure Gage #1.

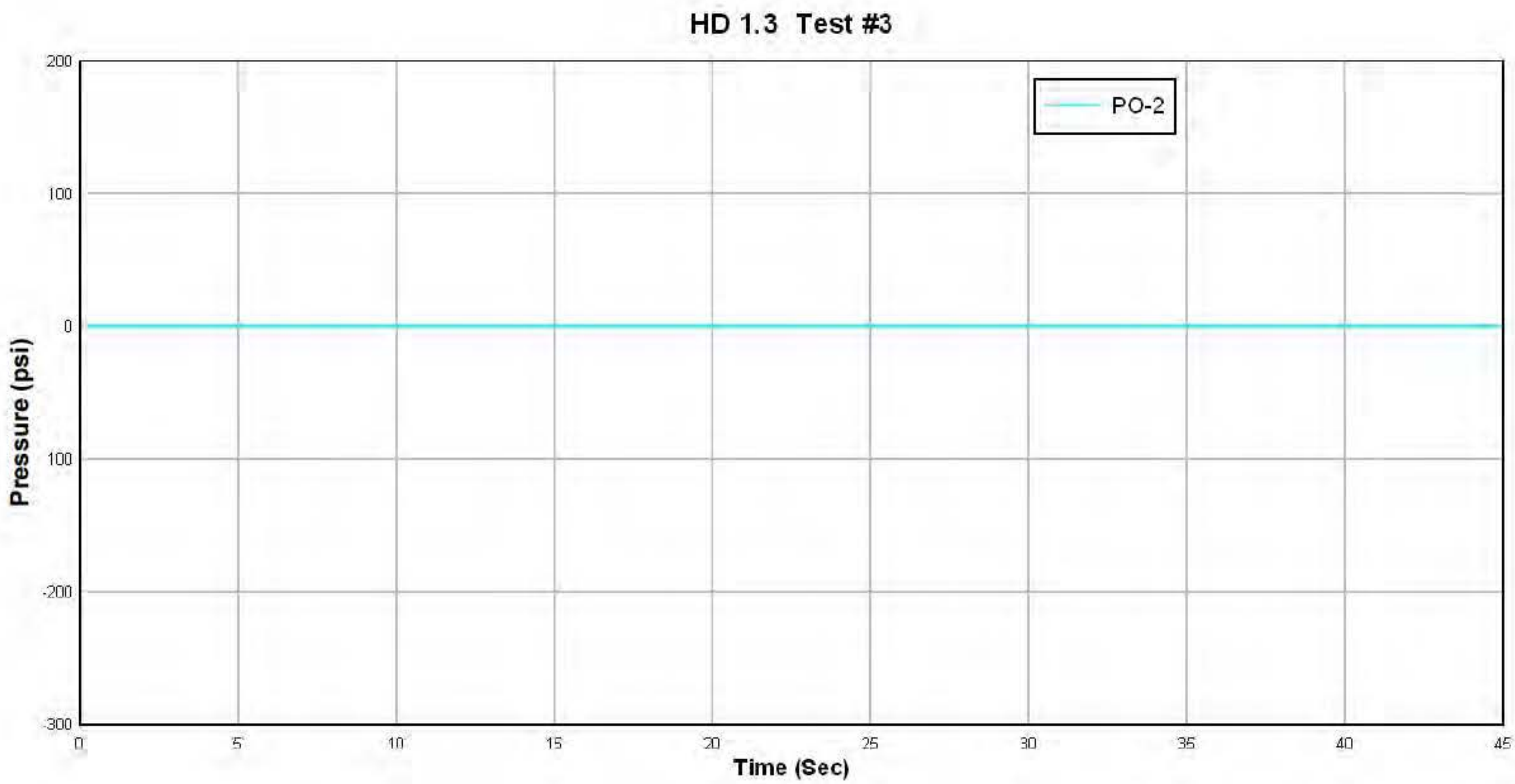

FIGURE IV-A-8. External Pressure Gage #2.

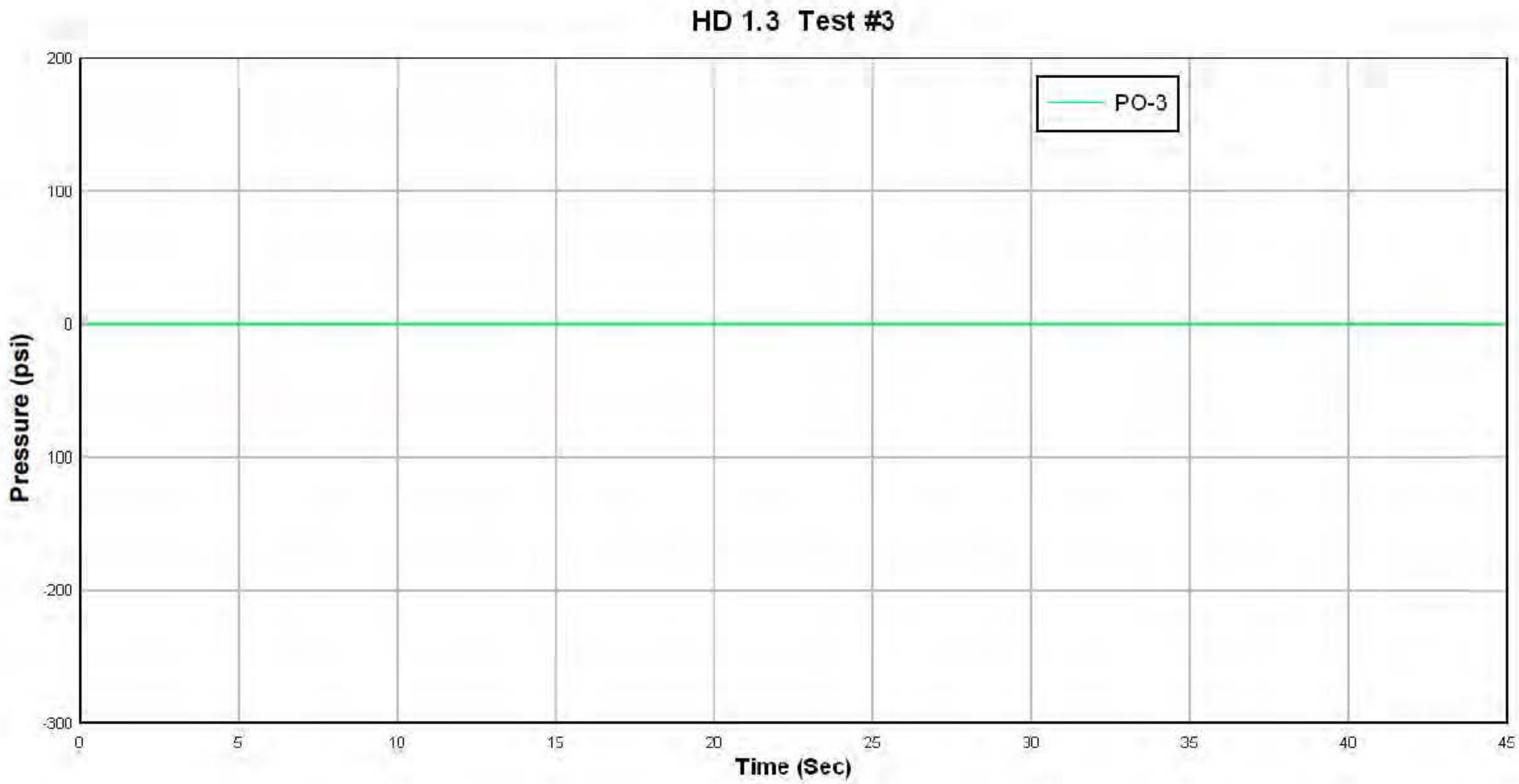

FIGURE IV-A-9. External Pressure Gage #3.

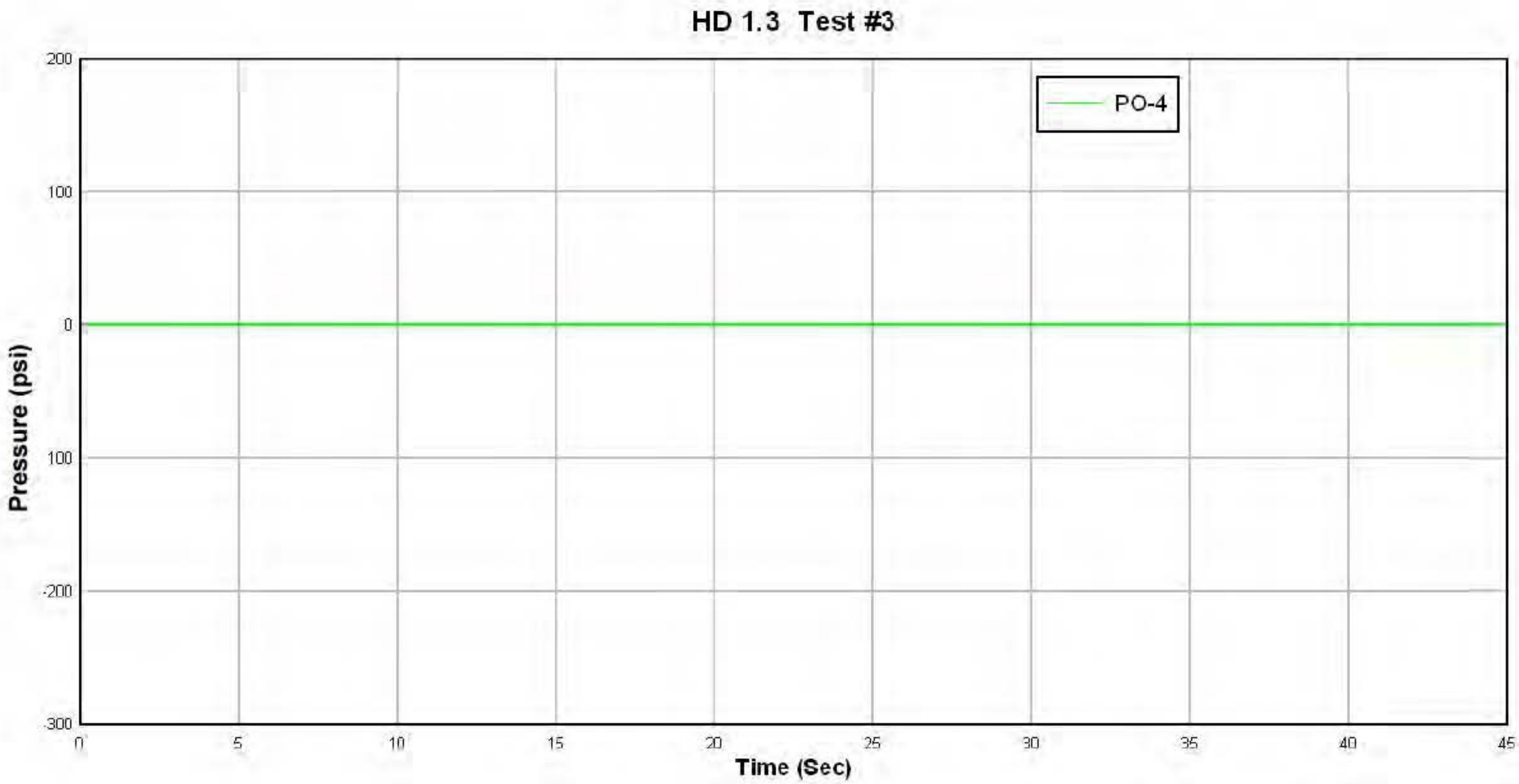

FIGURE IV-A-10. External Pressure Gage #4.

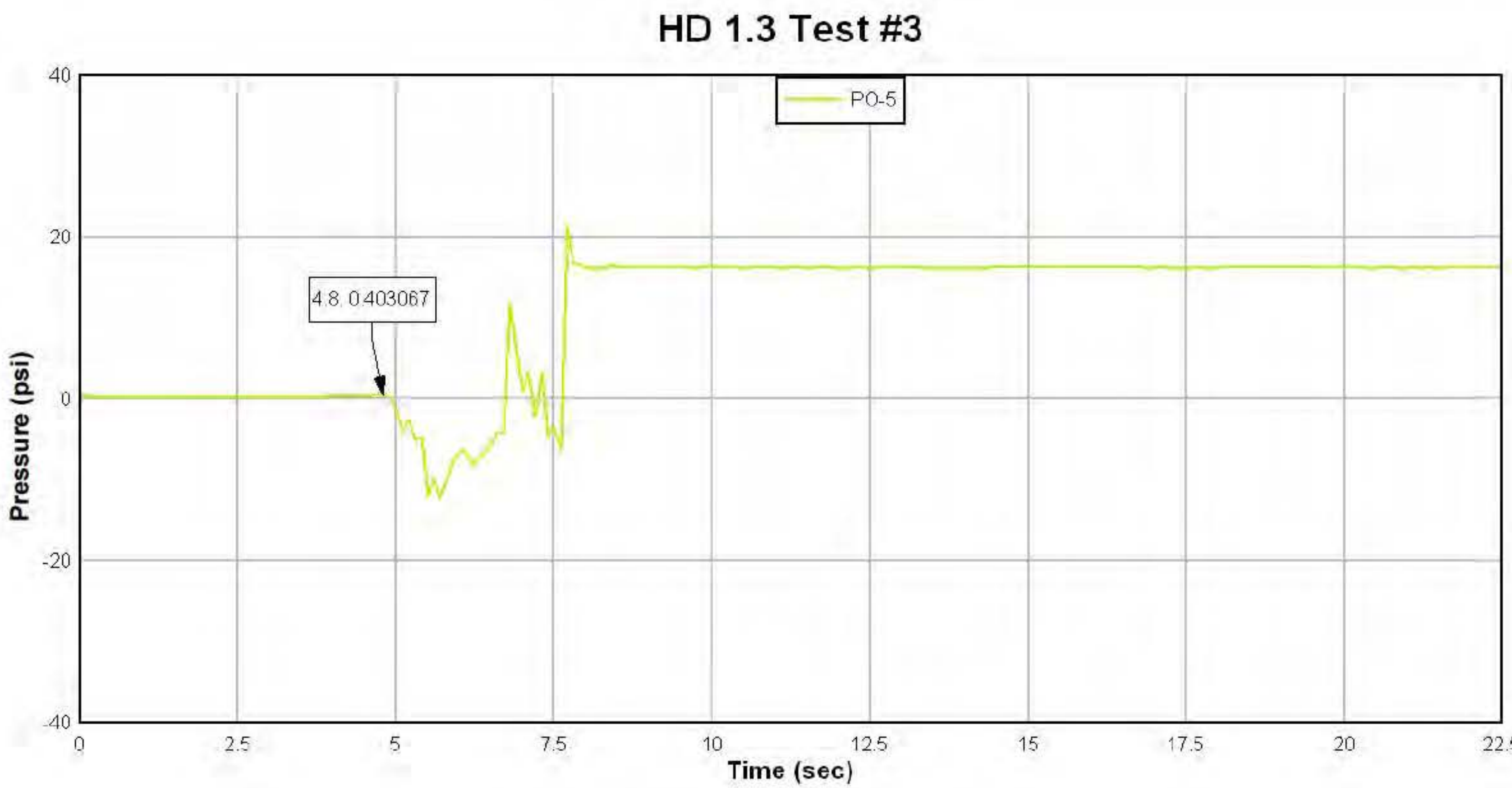

FIGURE IV-A-11. External Pressure Gage #5.

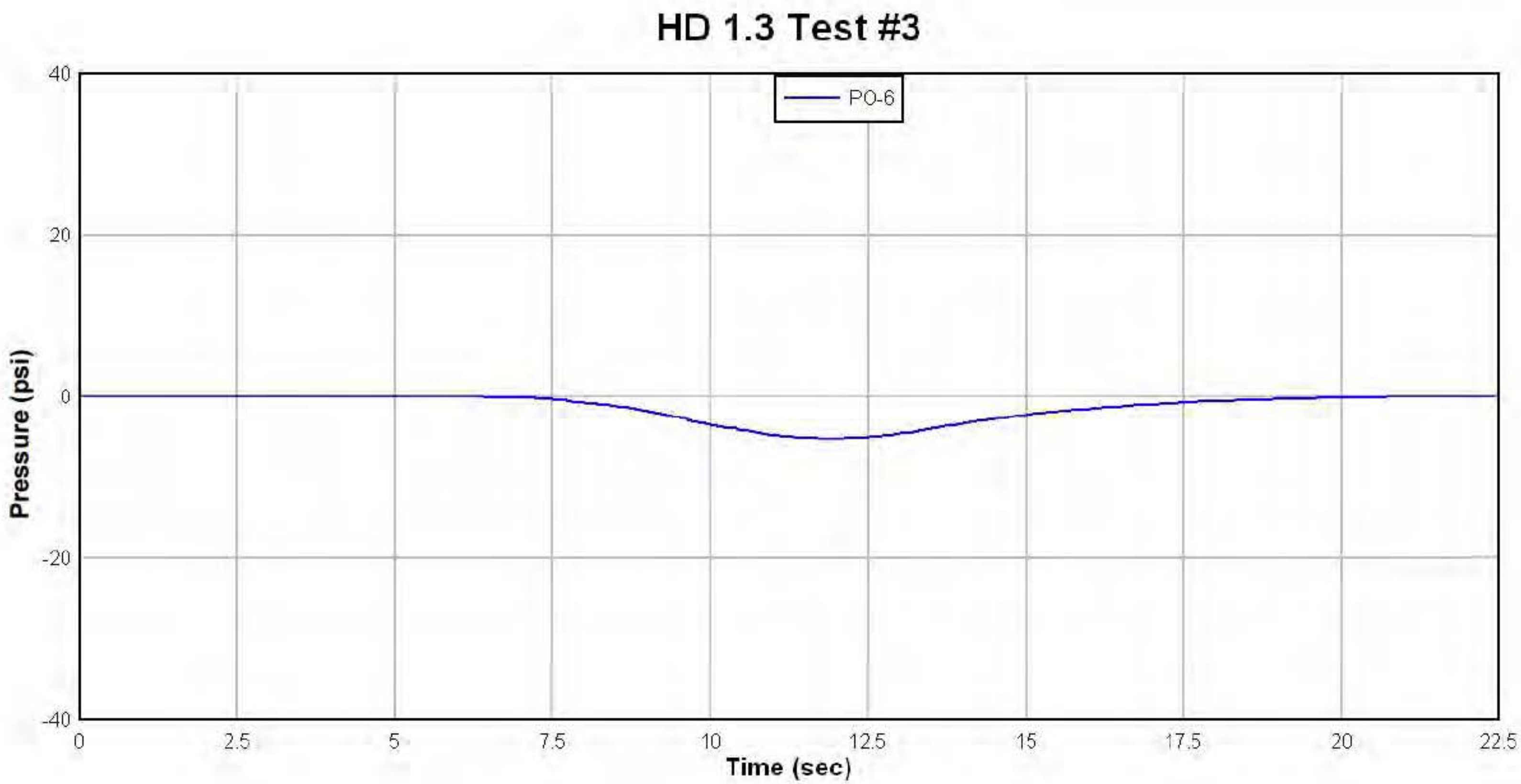

FIGURE IV-A-12. External Pressure Gage #6.

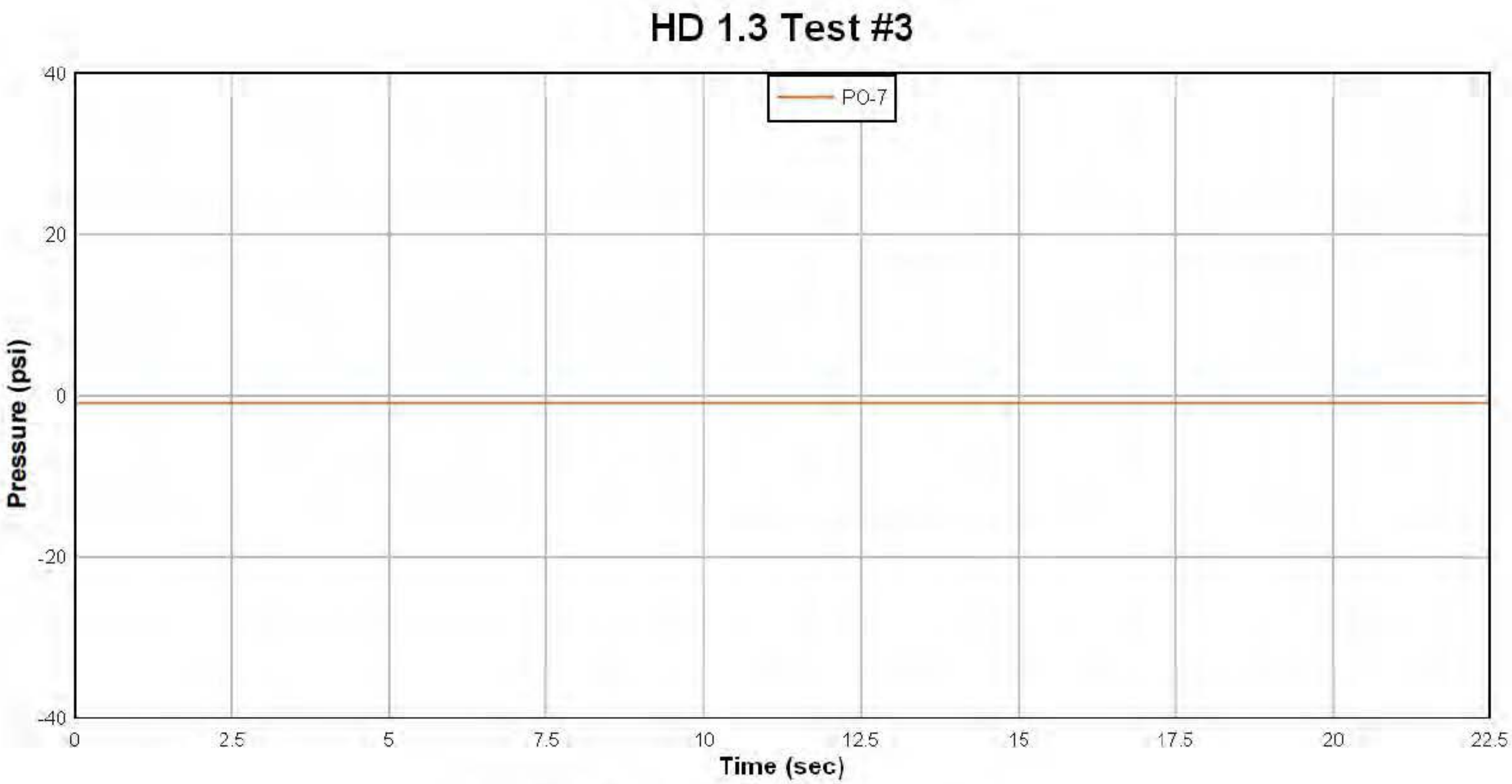

FIGURE IV-A-13. External Pressure Gage #7.

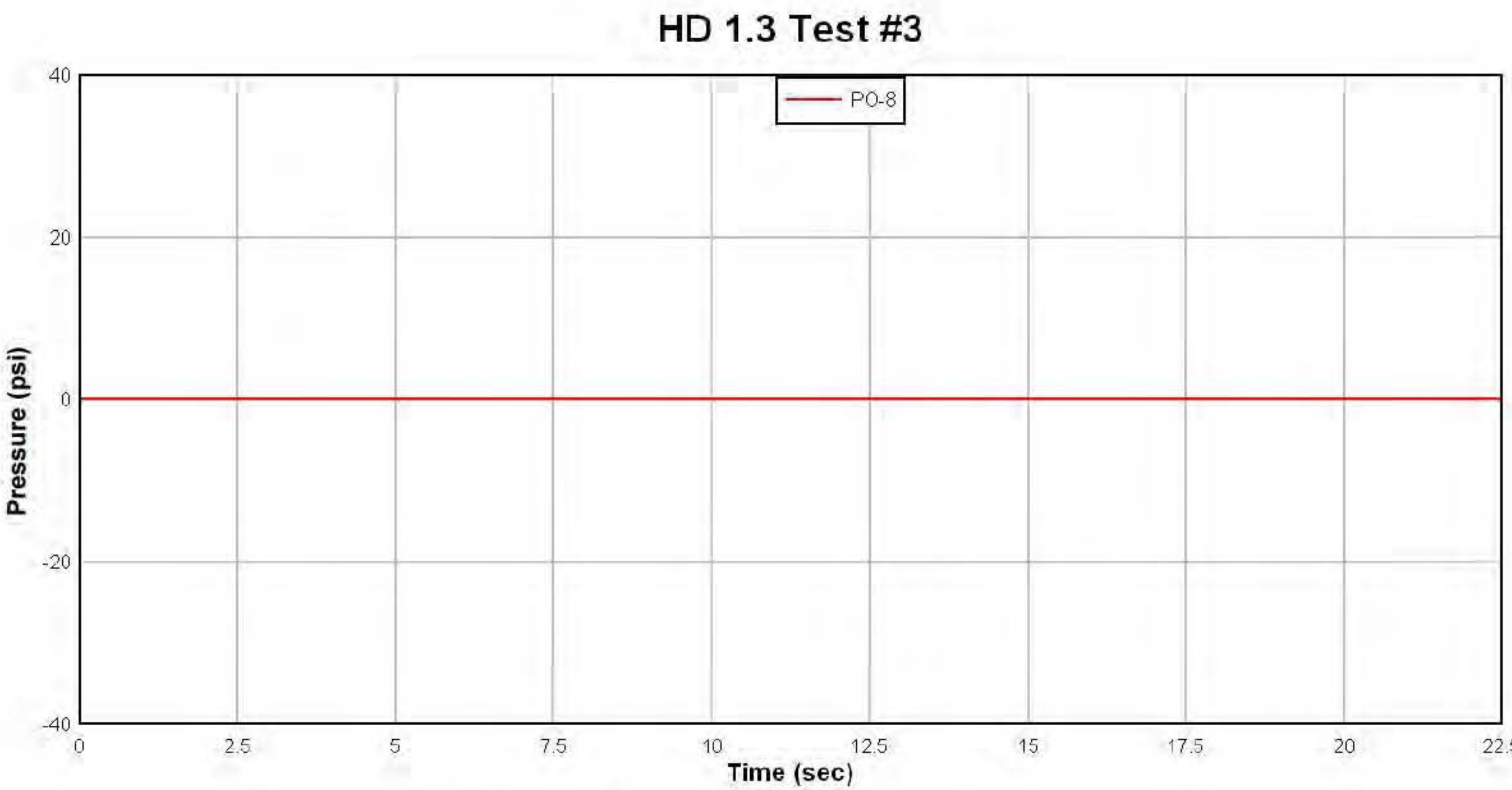

FIGURE IV-A-14. External Pressure Gage #8.

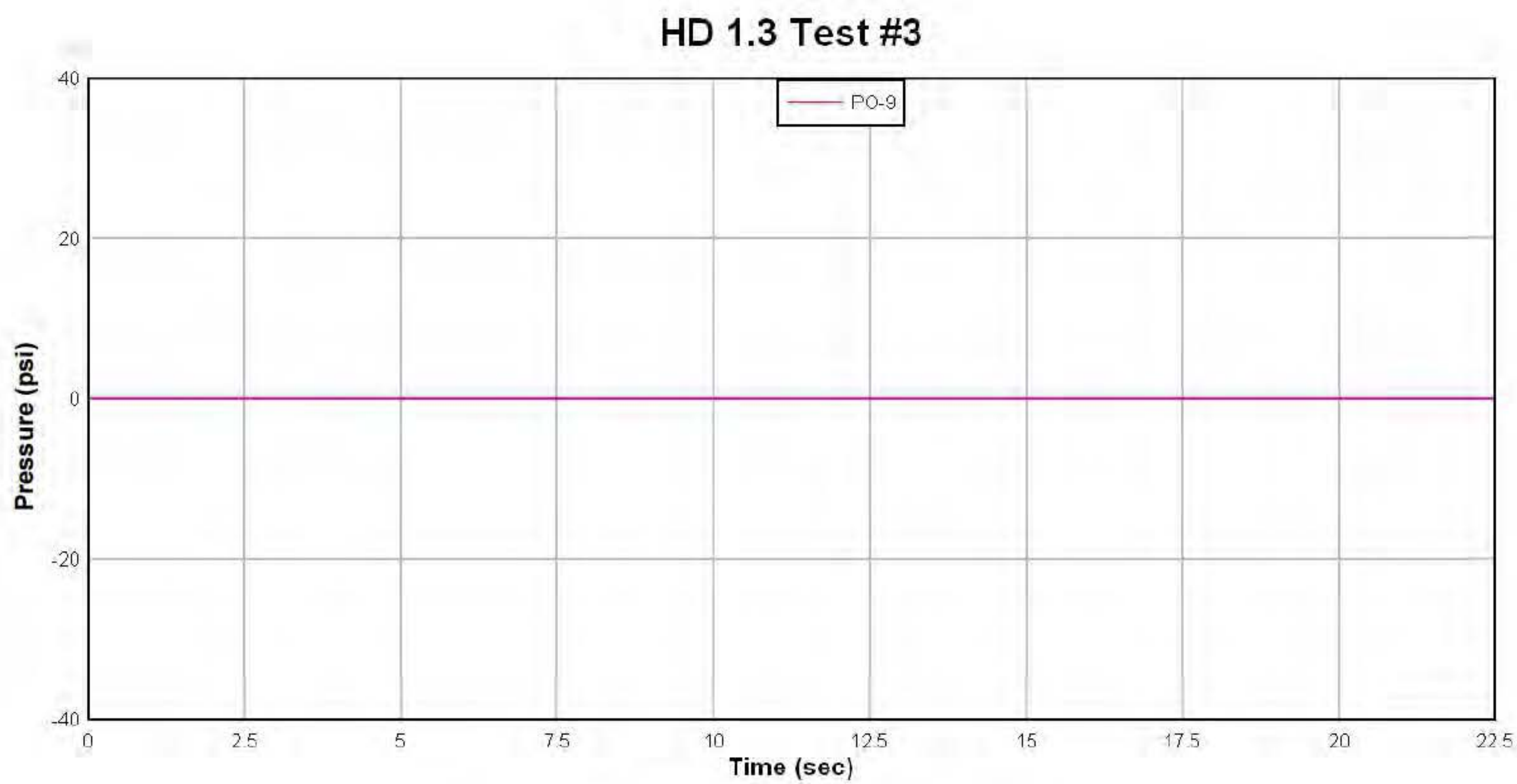

FIGURE IV-A-15. External Pressure Gage #9.

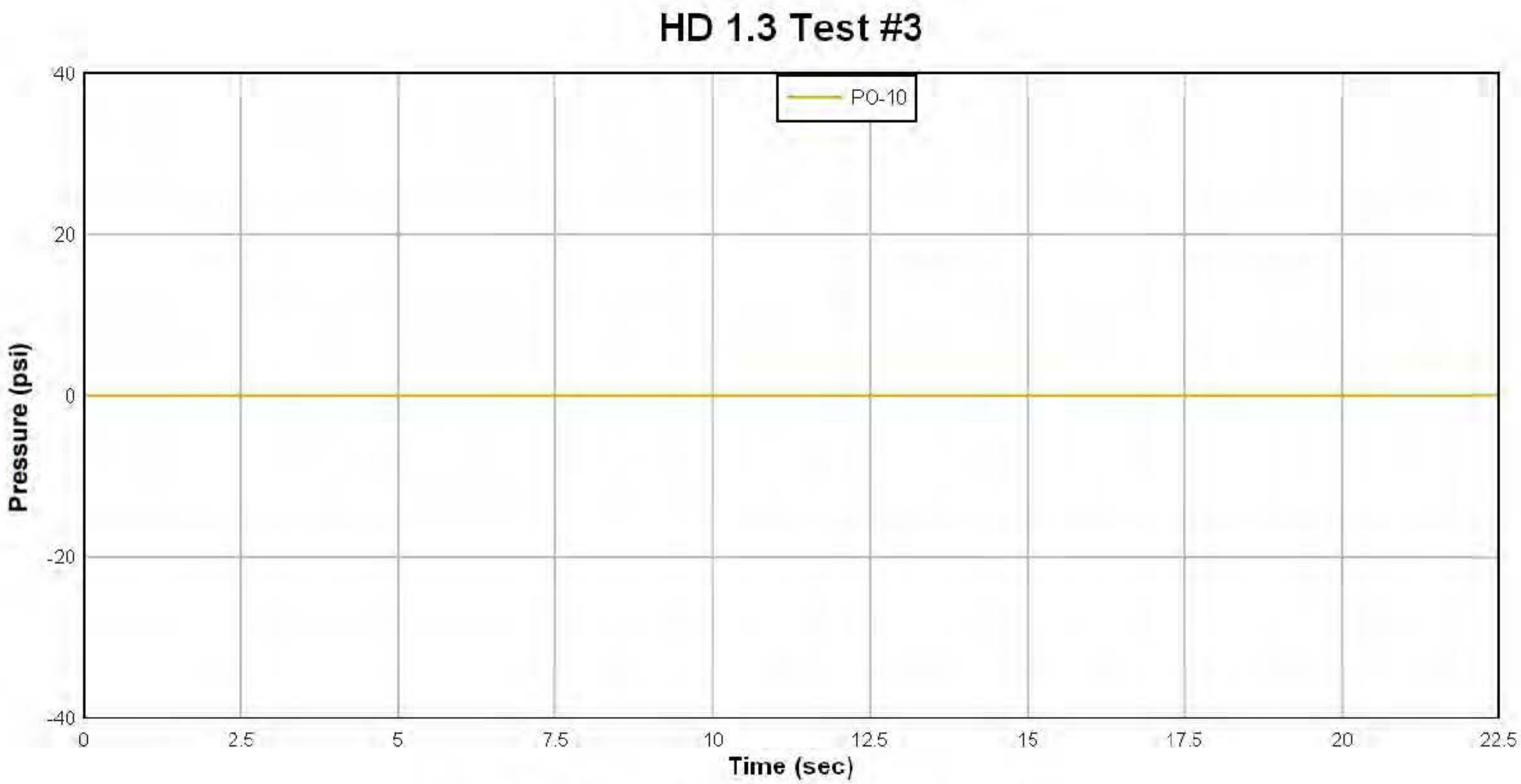

FIGURE IV-A-16. External Pressure Gage #10.

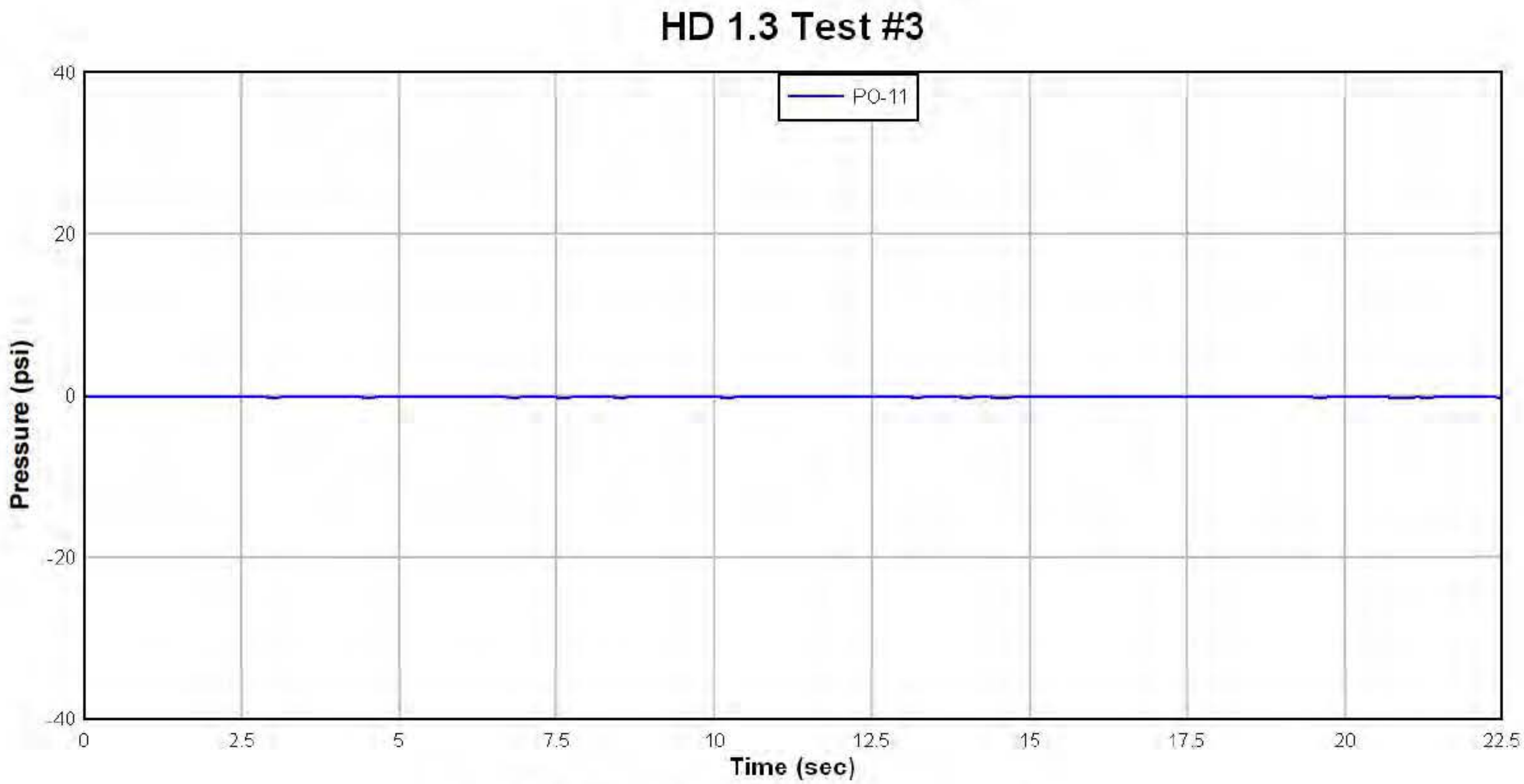

FIGURE IV-A-17. External Pressure Gage #11.

Summary

- Peak Internal Pressure 51.84 psi at Gage 3 at 1.39 sec
- Peak External Pressure 34.16 psi at gage 5 at 1.4 seconds

PRESSURE DATA FOR TEST 3 INSIDE STRUCTURE

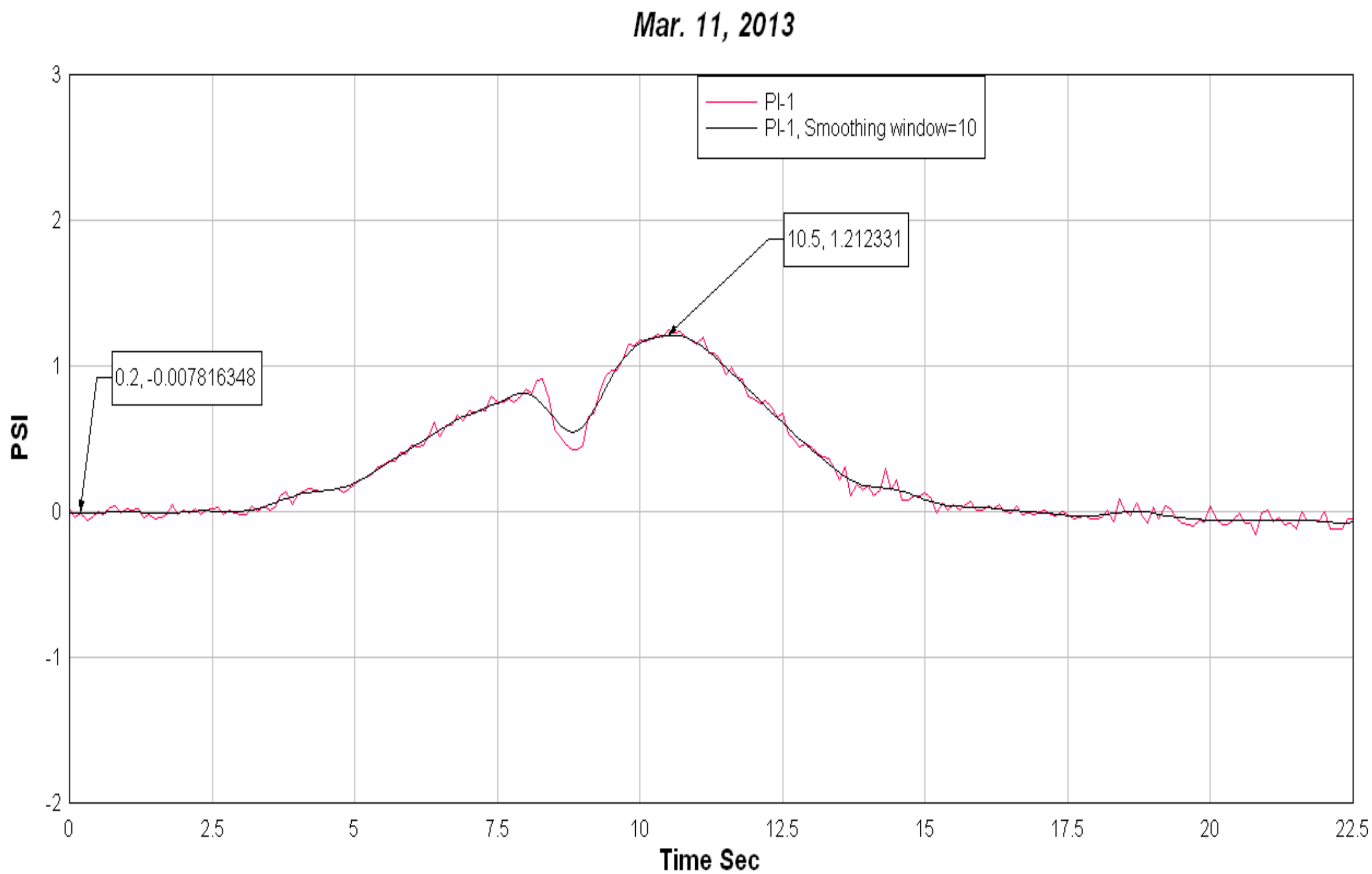

FIGURE IV-A-18. HD 1-3 Effects Test 3.

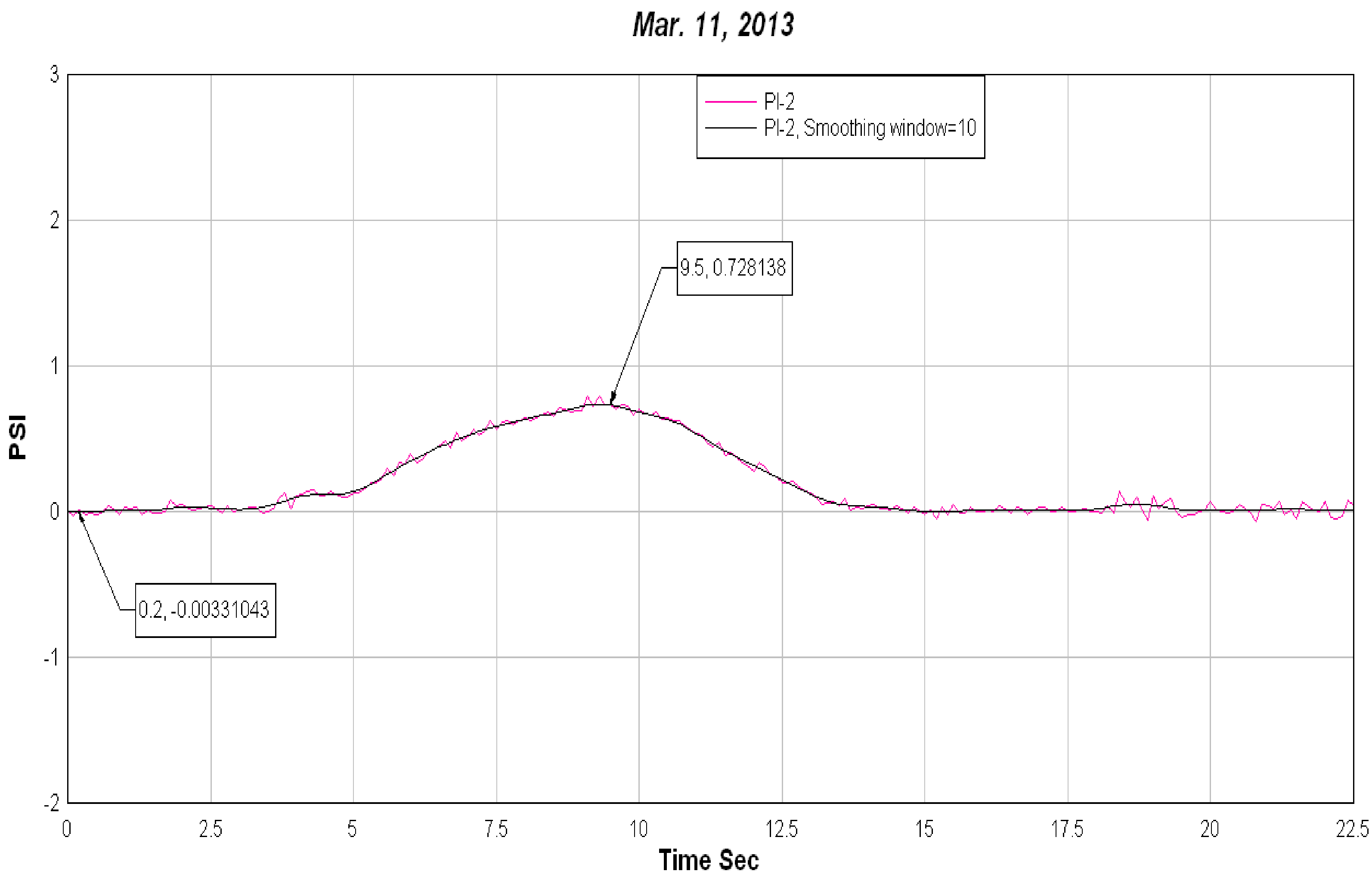

FIGURE IV-A-19. HD 1-3 Effects Test 3.

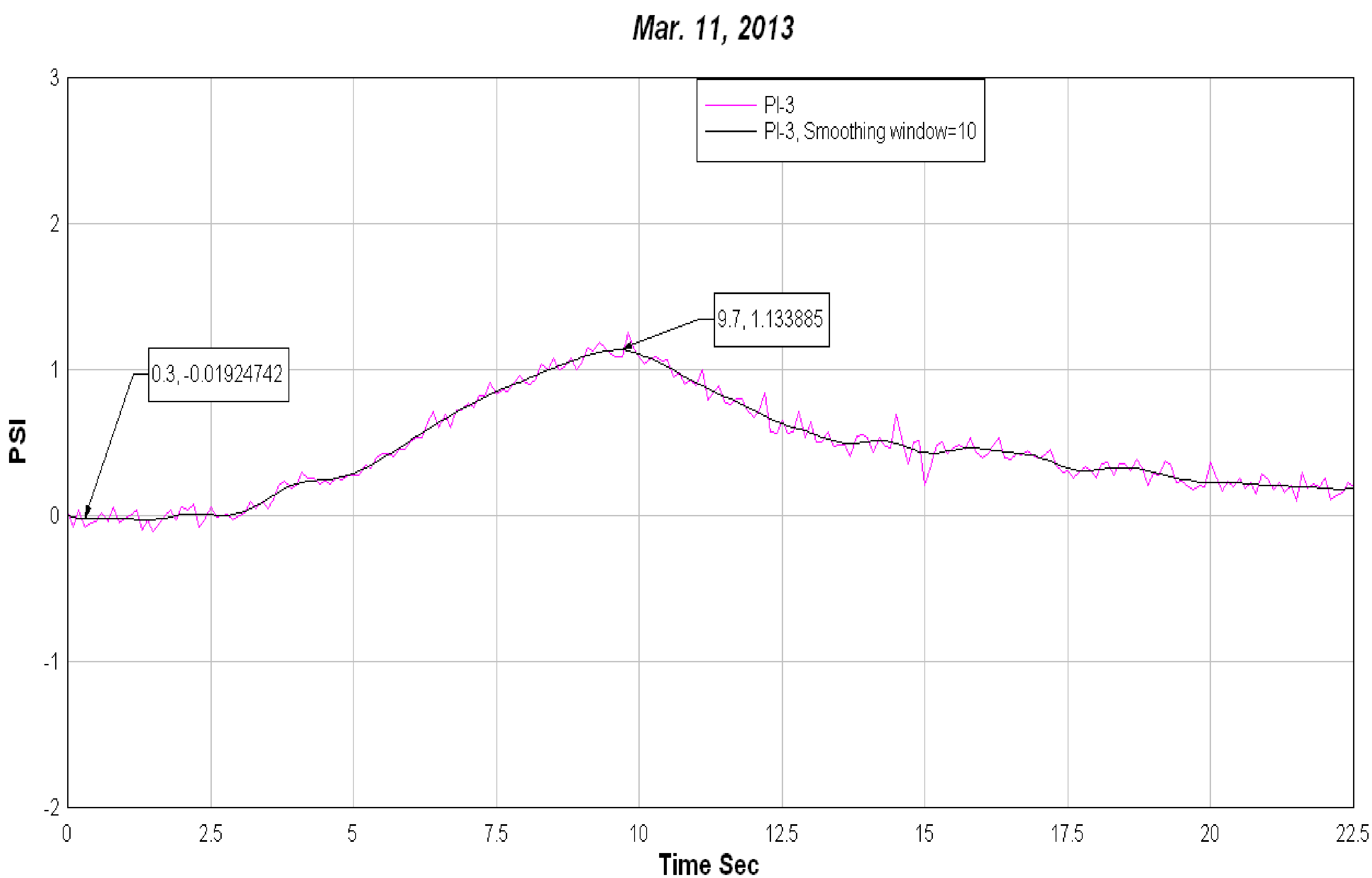

FIGURE IV-A-20. HD 1-3 Effects Test 3.

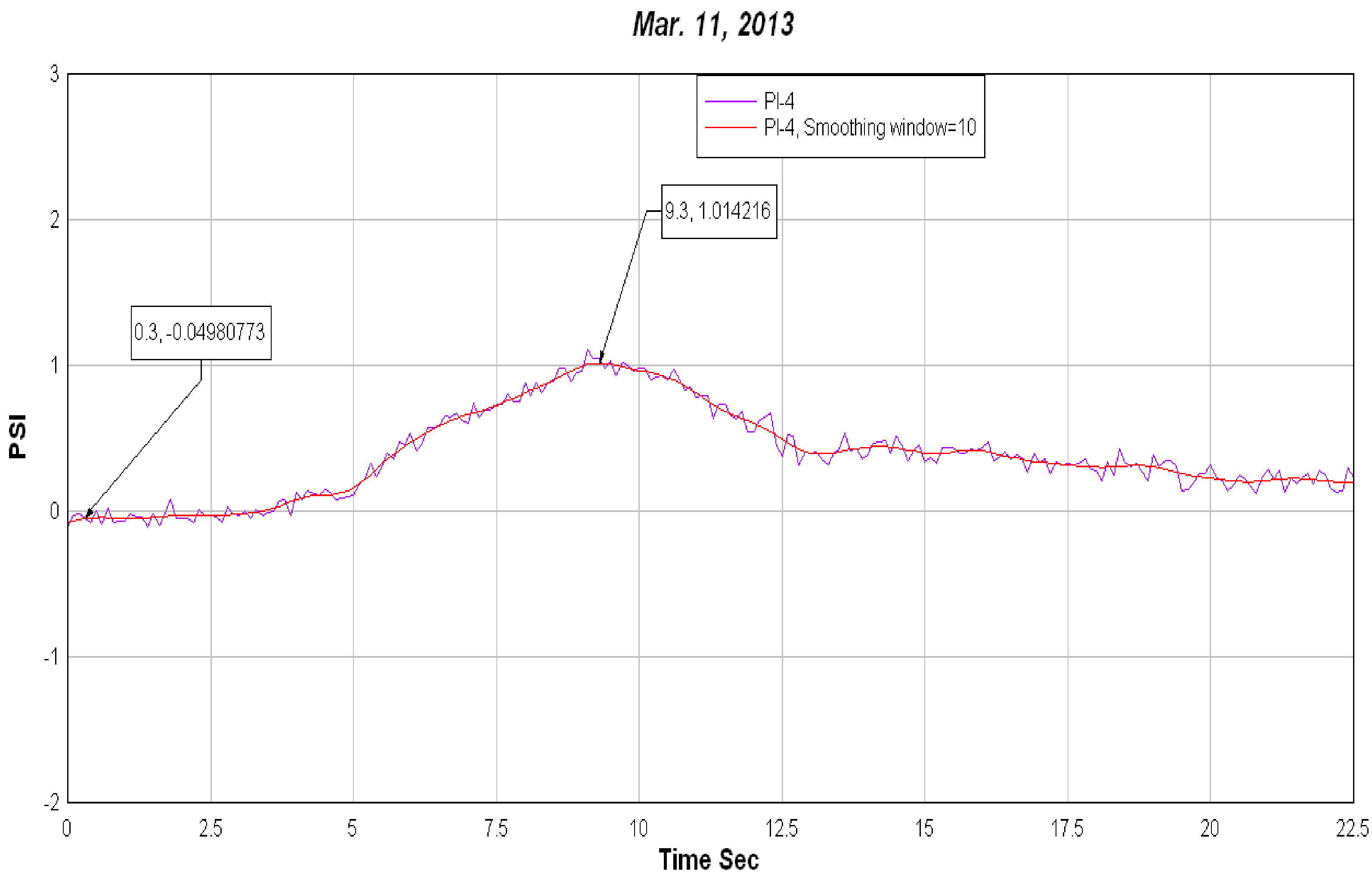

FIGURE IV-A-21. HD 1-3 Effects Test 3.

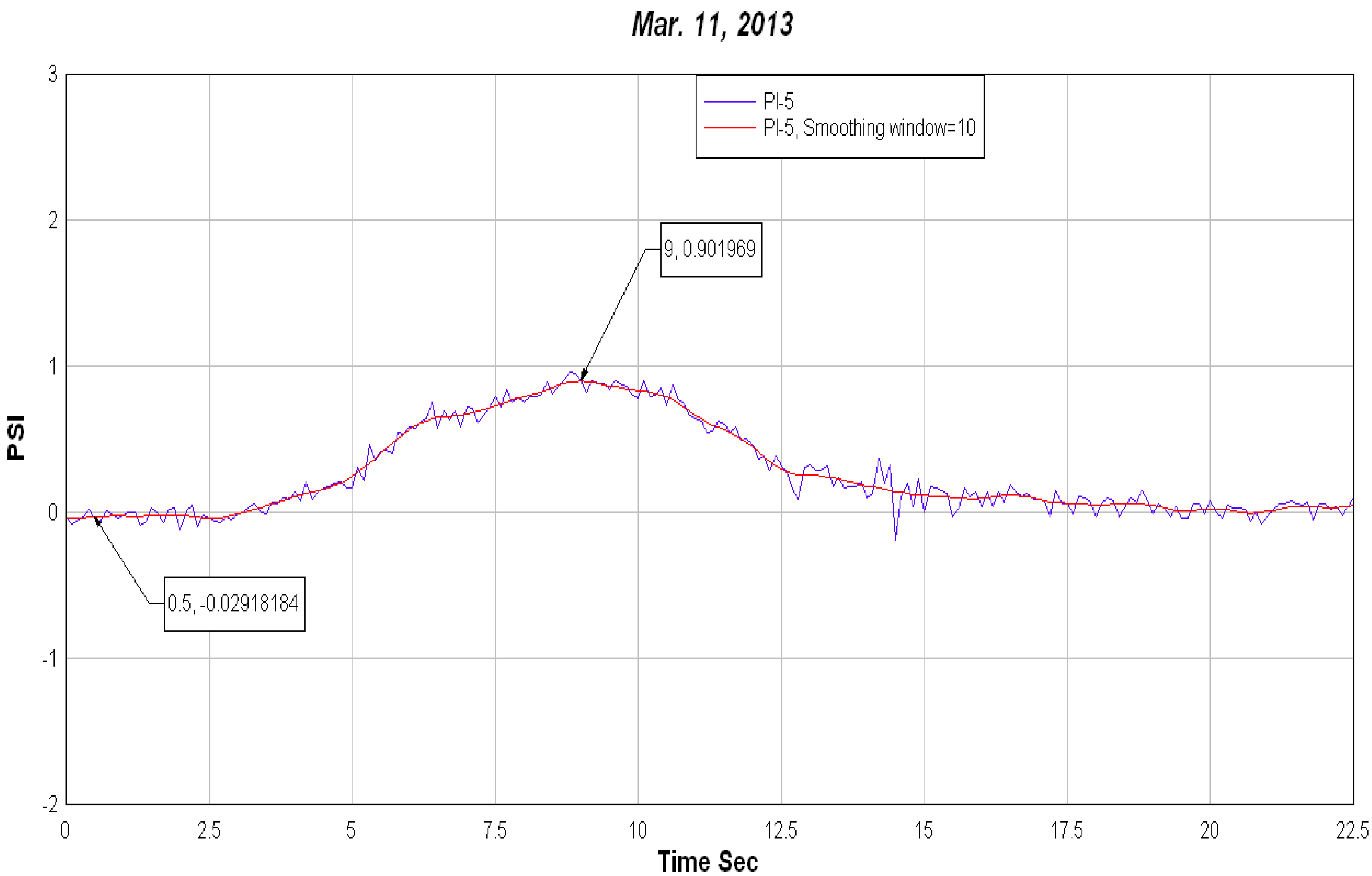

FIGURE IV-A-22. HD 1-3 Effects Test 3.

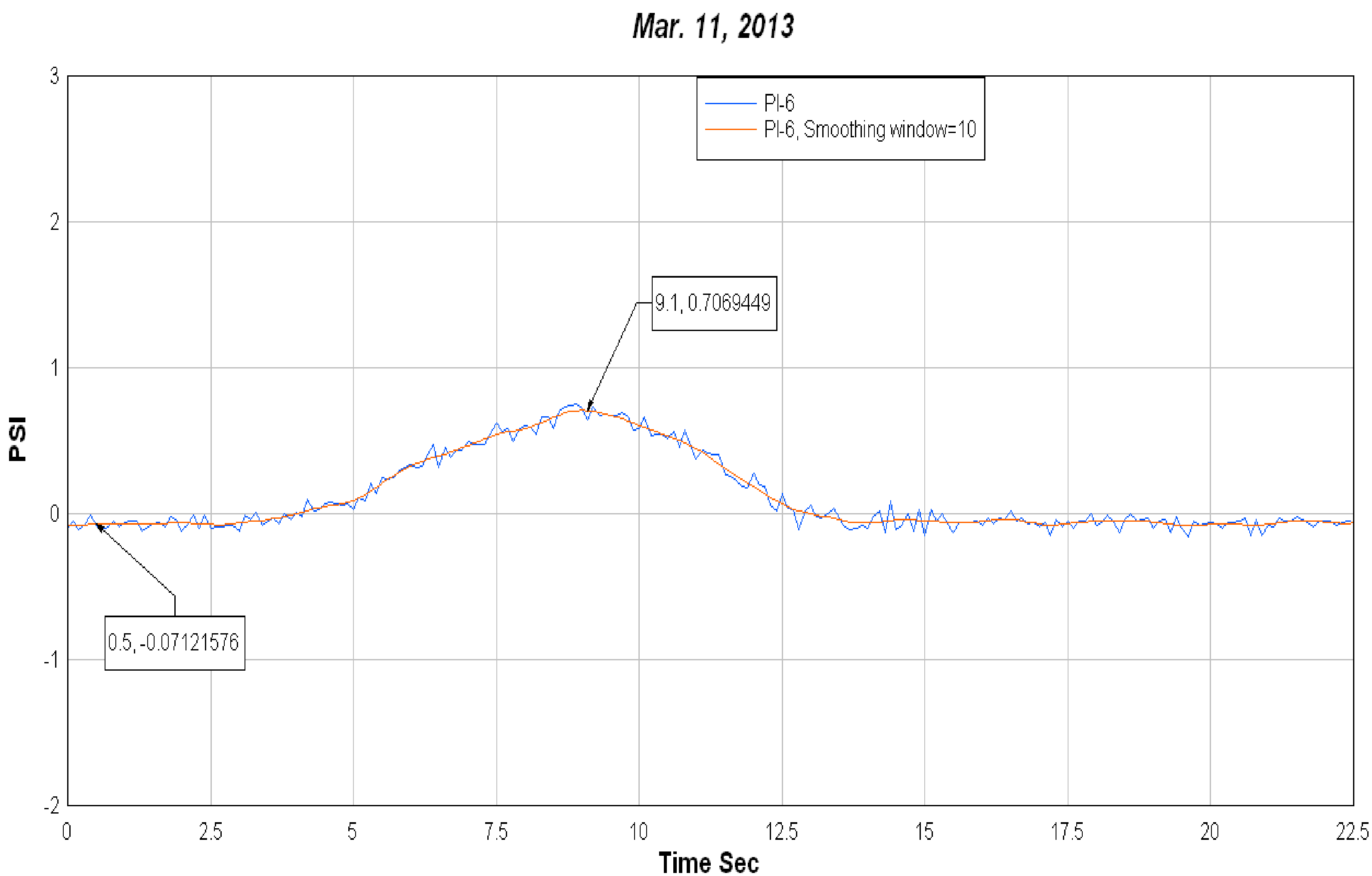

FIGURE IV-A-23. HD 1-3 Effects Test 3.

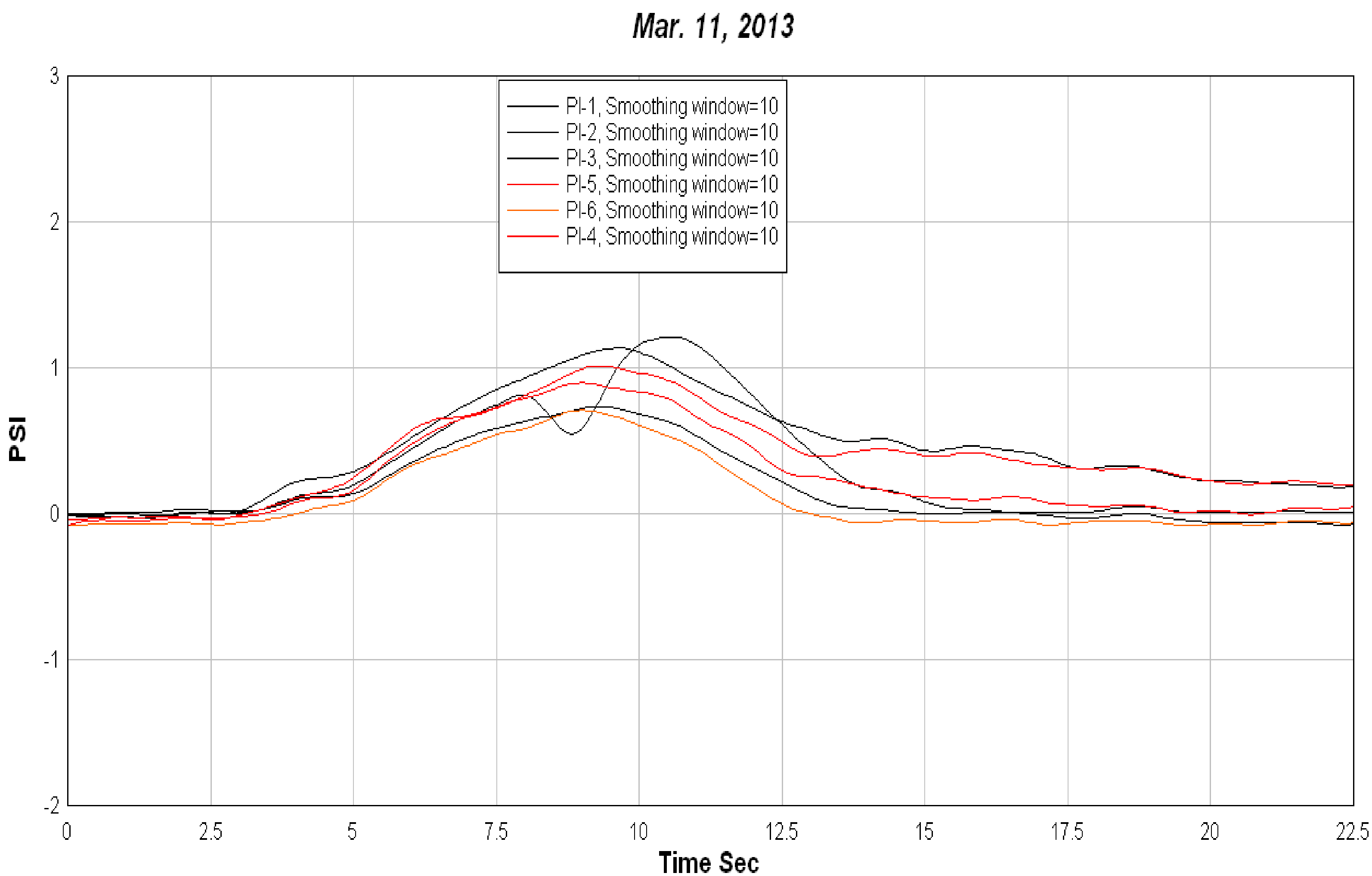

FIGURE IV-A-24. HD 1-3 Effects Test 3.

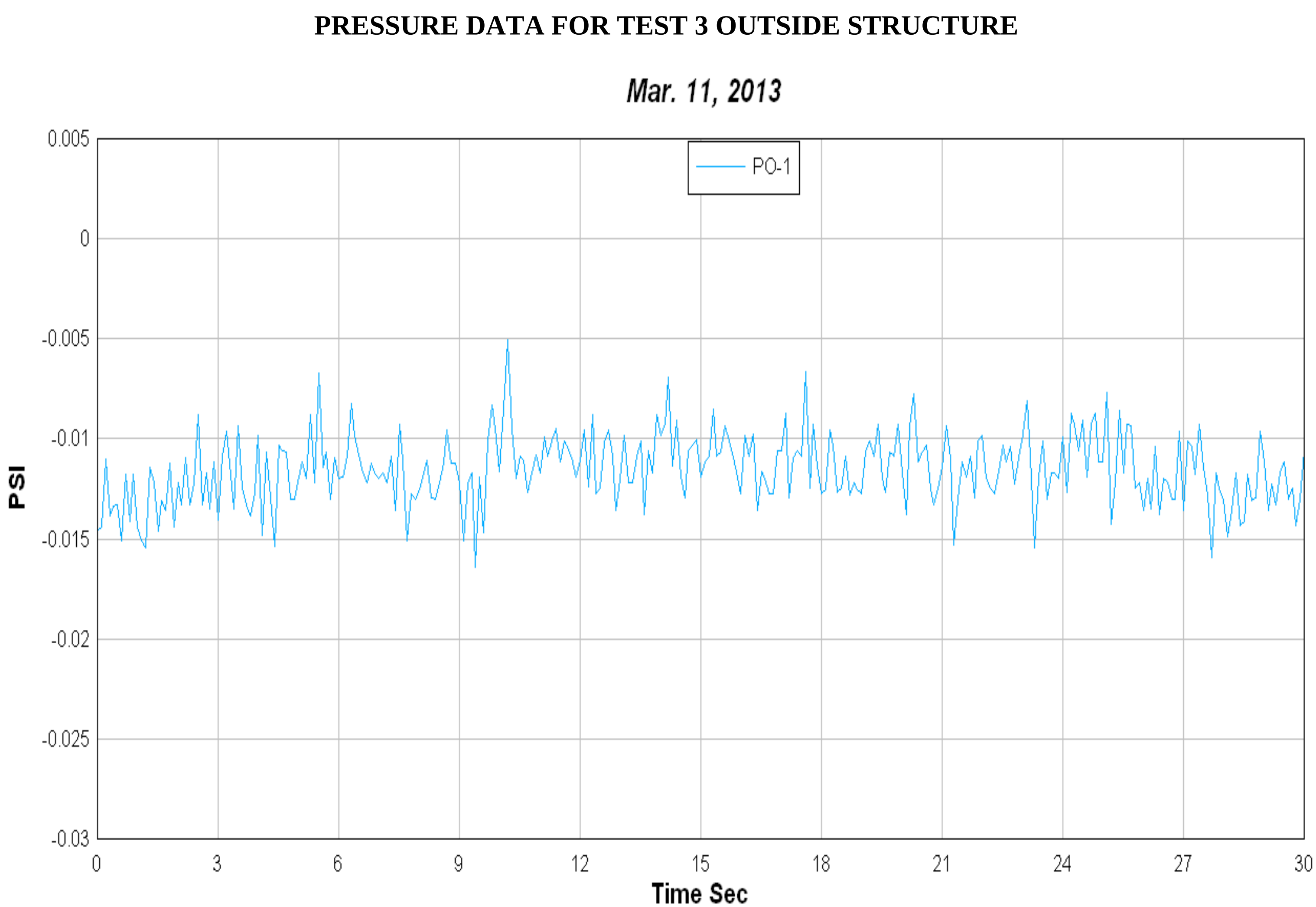

FIGURE IV-A-25. HD 1-3 Effects Test 3.

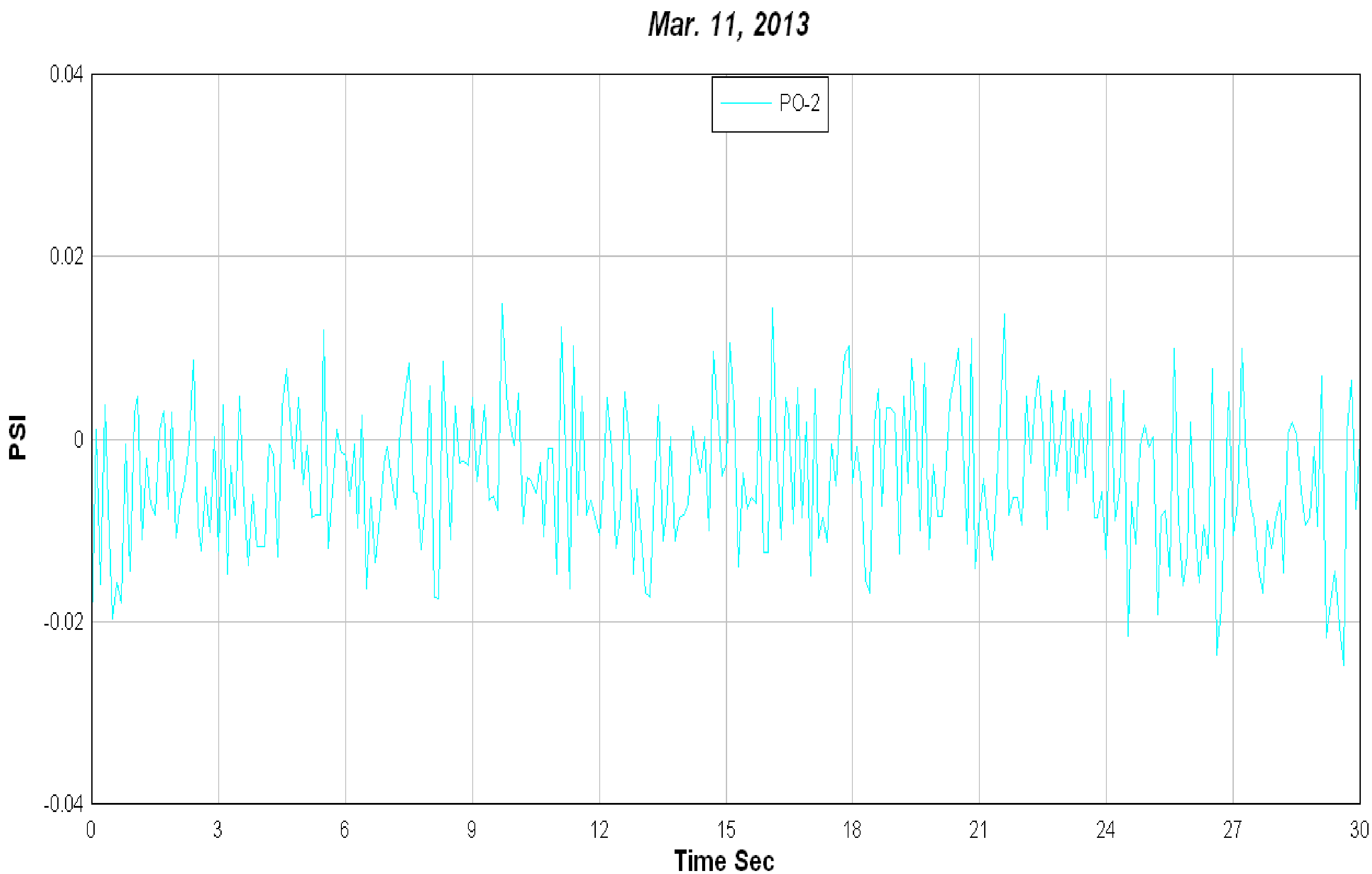

FIGURE IV-A-26. HD 1-3 Effects Test 3.

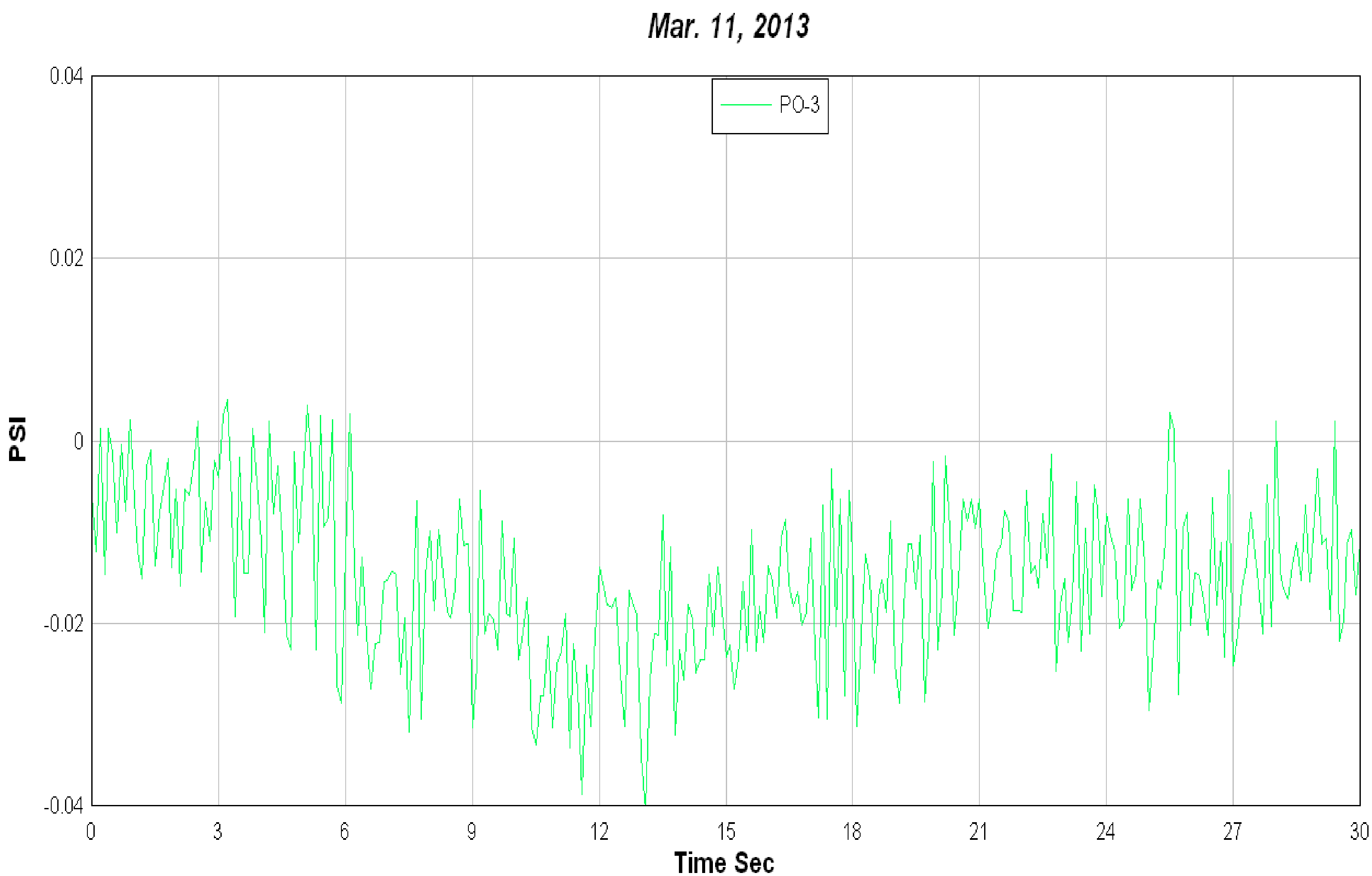

FIGURE IV-A-27. HD 1-3 Effects Test 3.

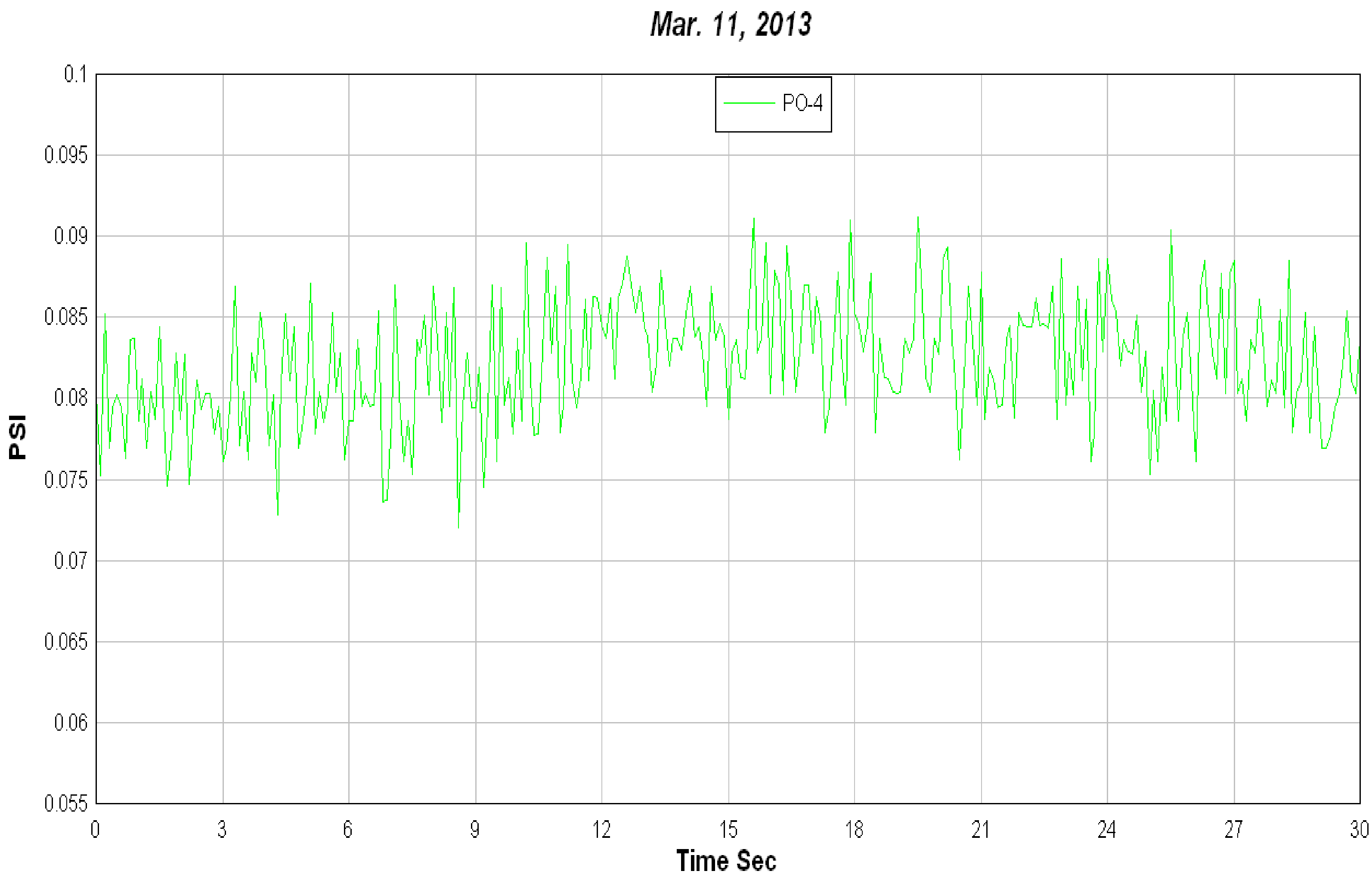

FIGURE IV-A-28. HD 1-3 Effects Test 3.

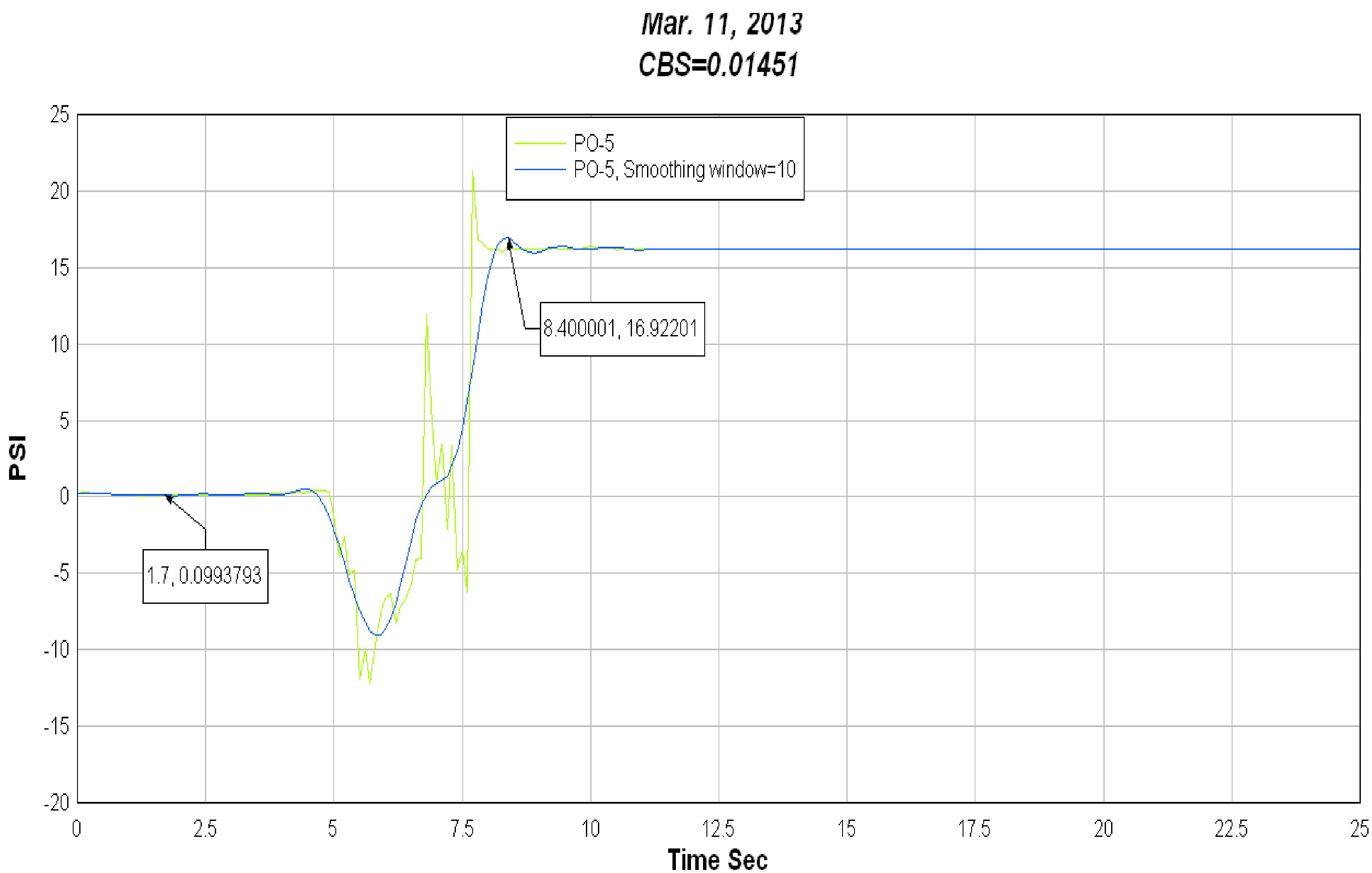

FIGURE IV-A-29. HD 1-3 Effects Test 3.

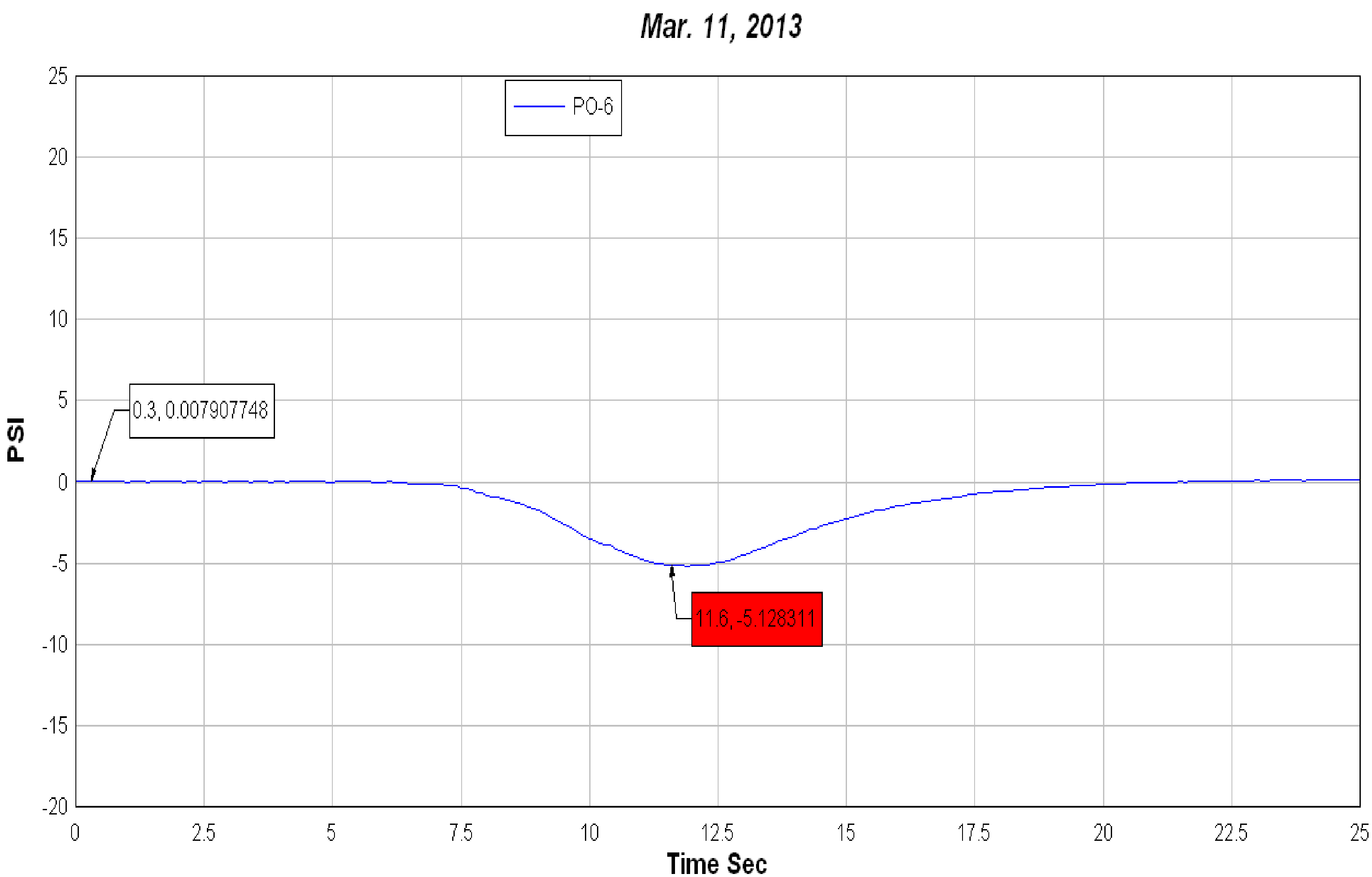

FIGURE IV-A-30. HD 1-3 Effects Test 3.

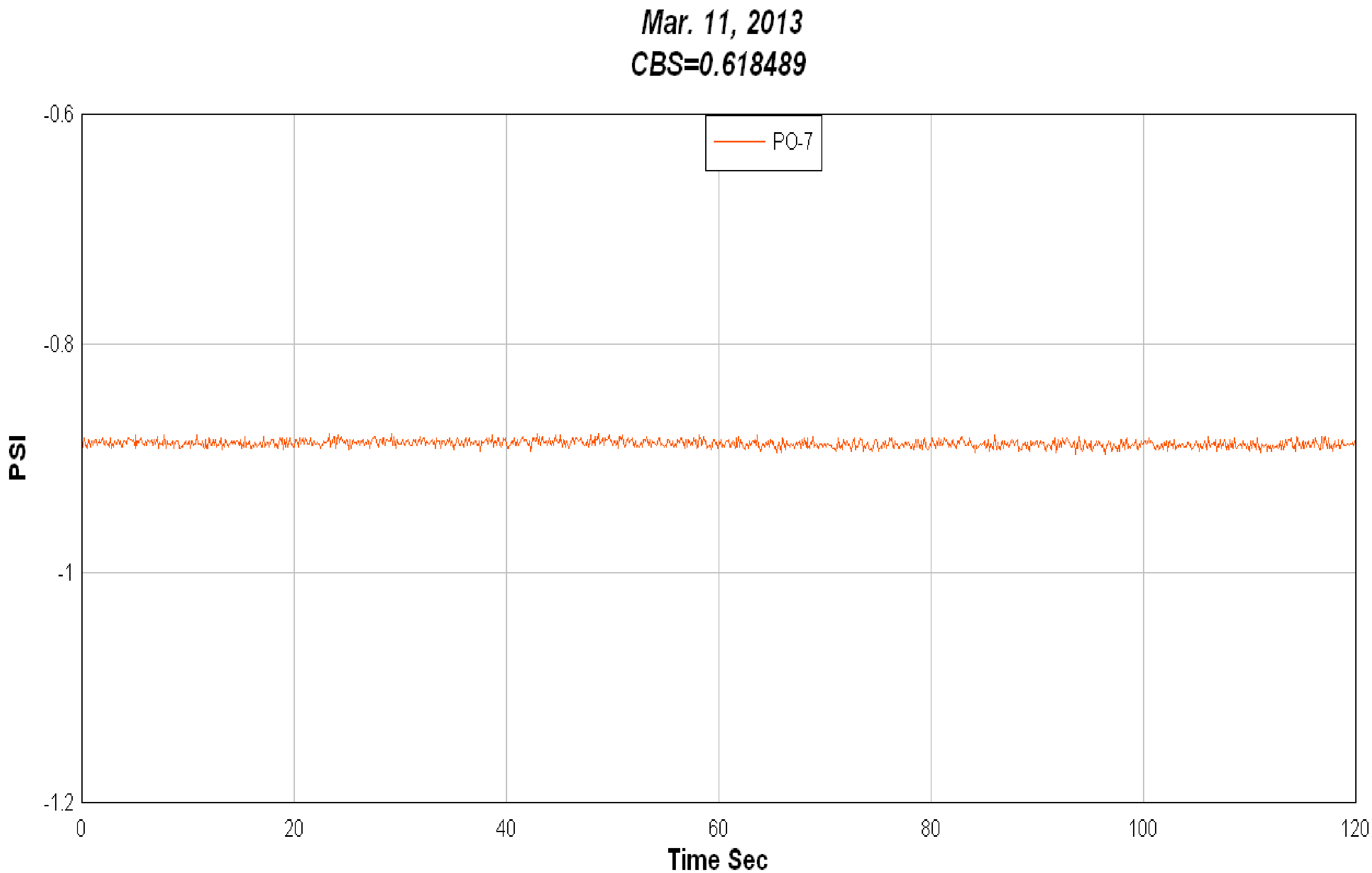

FIGURE IV-A-31. HD 1-3 Effects Test 3.

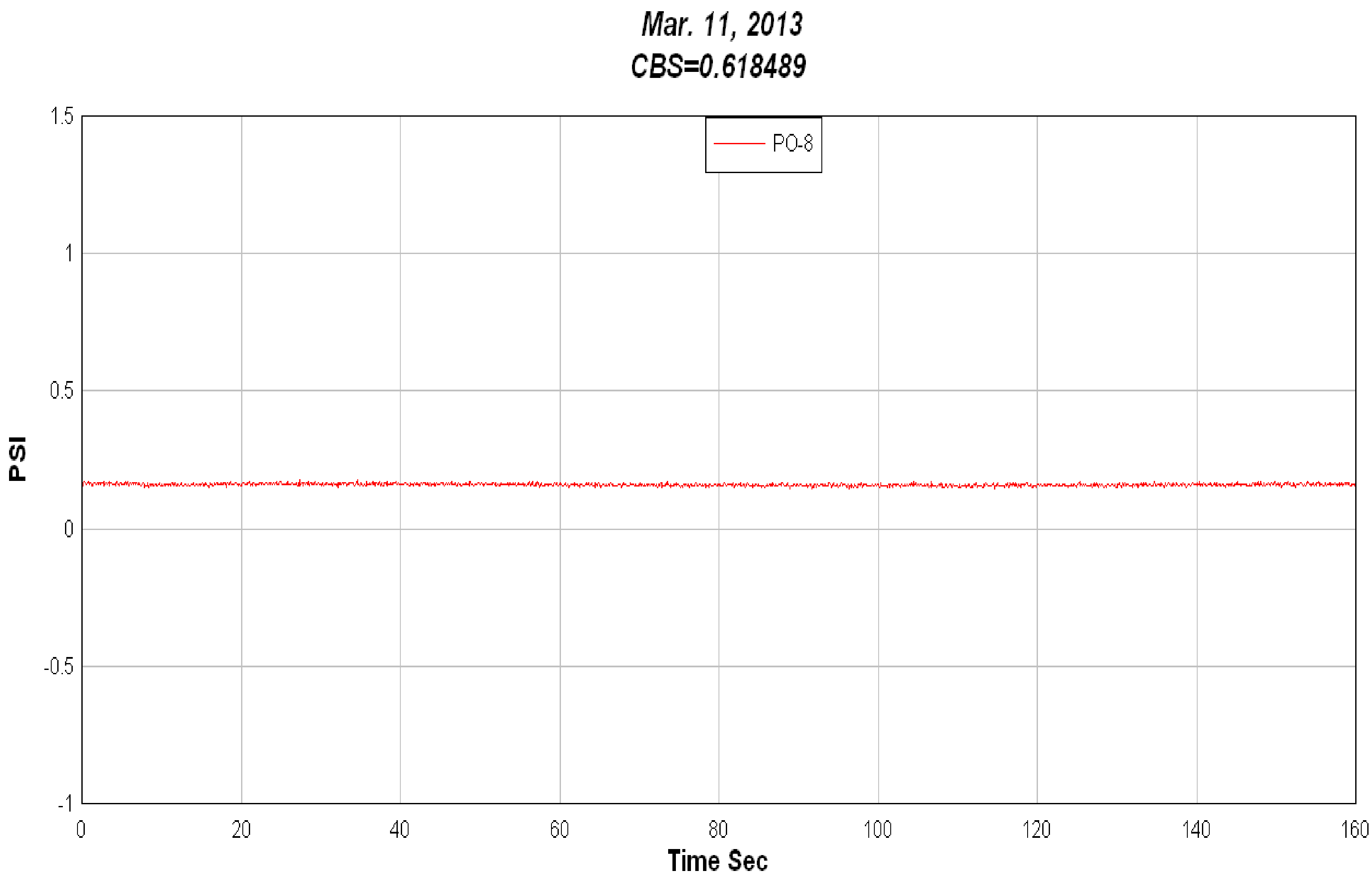

FIGURE IV-A-32. HD 1-3 Effects Test 3.

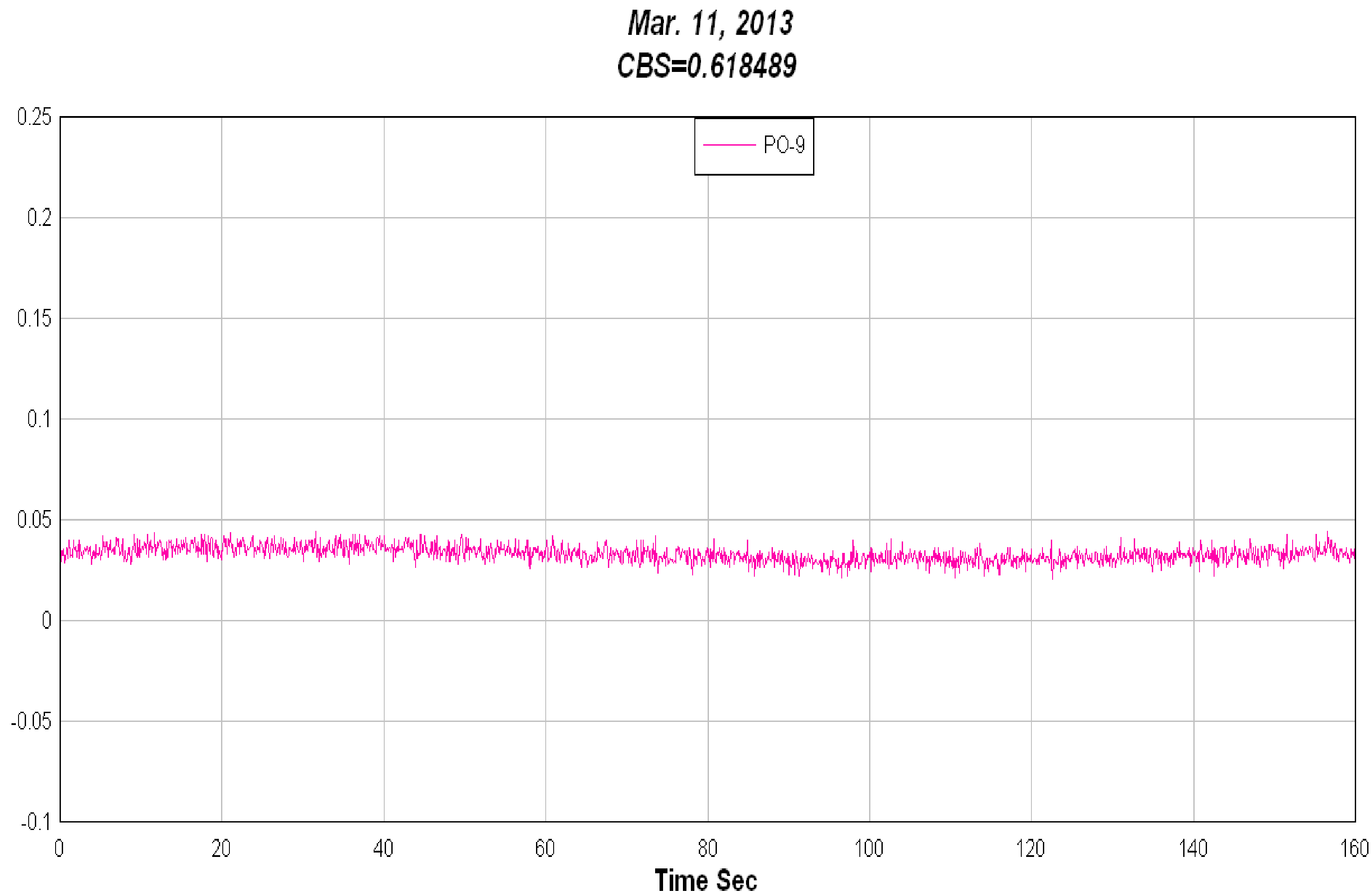

FIGURE IV-A-33. HD 1-3 Effects Test 3.

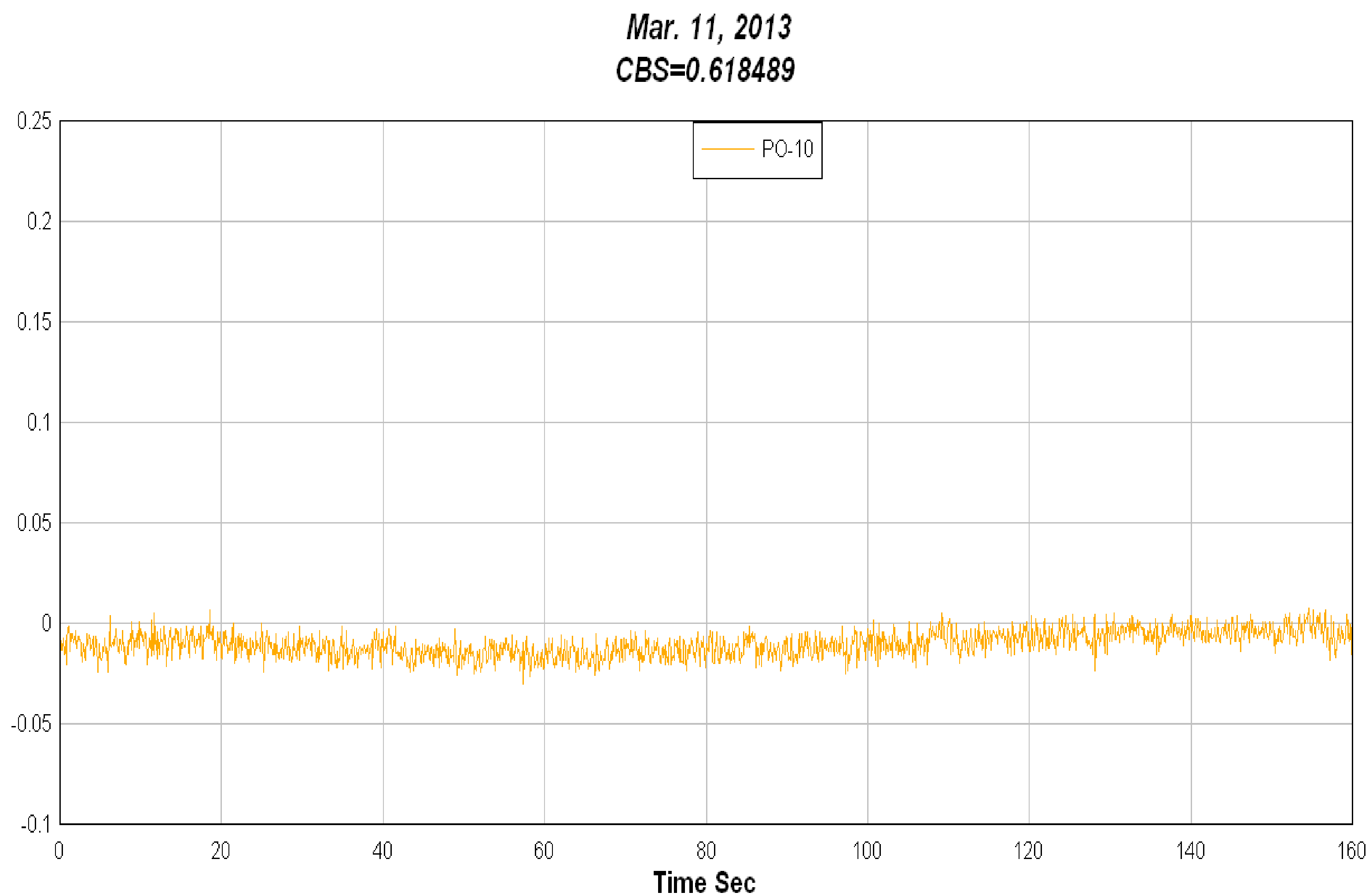

FIGURE IV-A-34. HD 1-3 Effects Test 3.

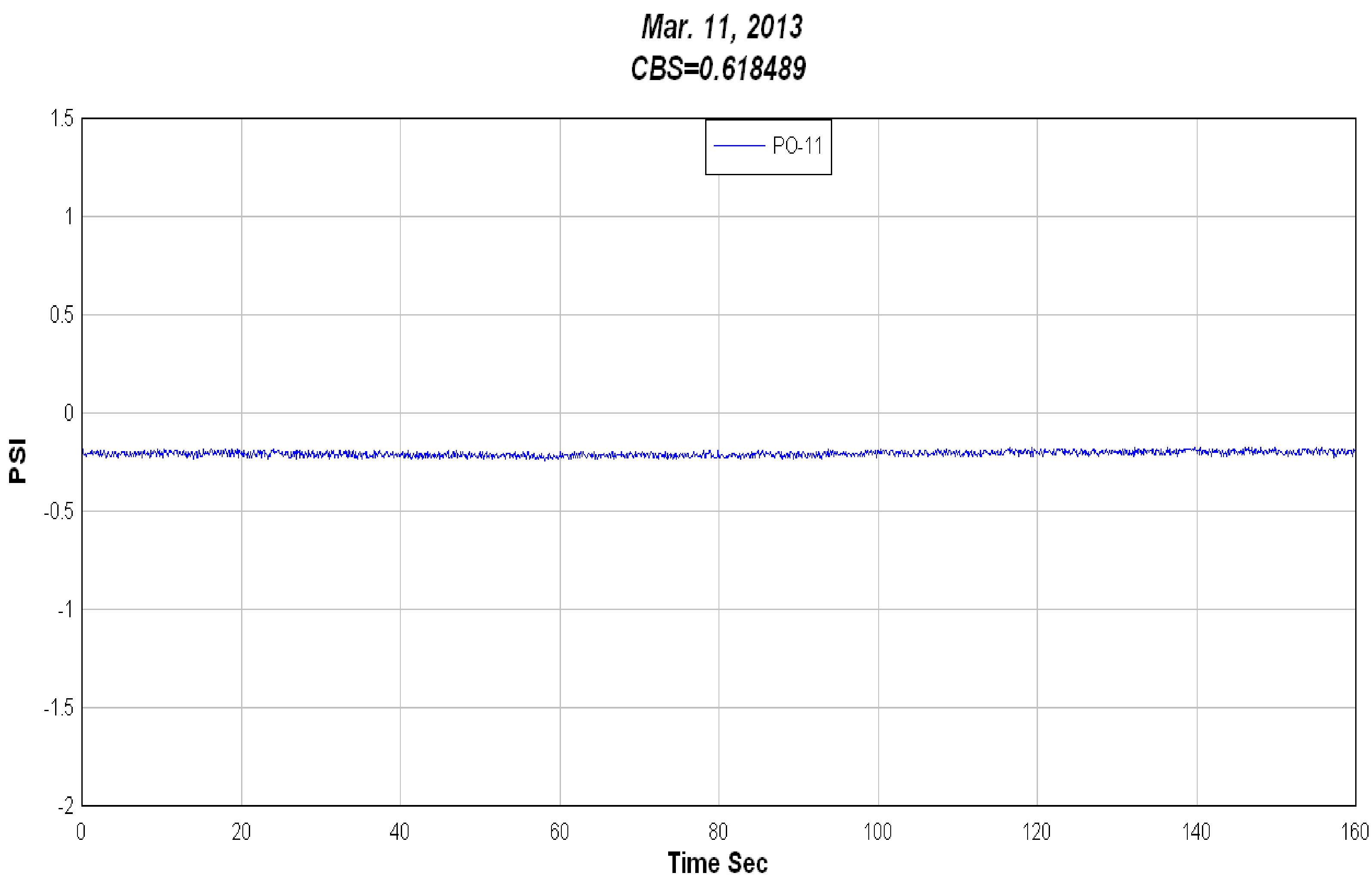

FIGURE IV-A-35. HD 1-3 Effects Test 3.

Appendix IV-B

HD1.3 TEST 3. TEMPERATURE AND FLUX DATA

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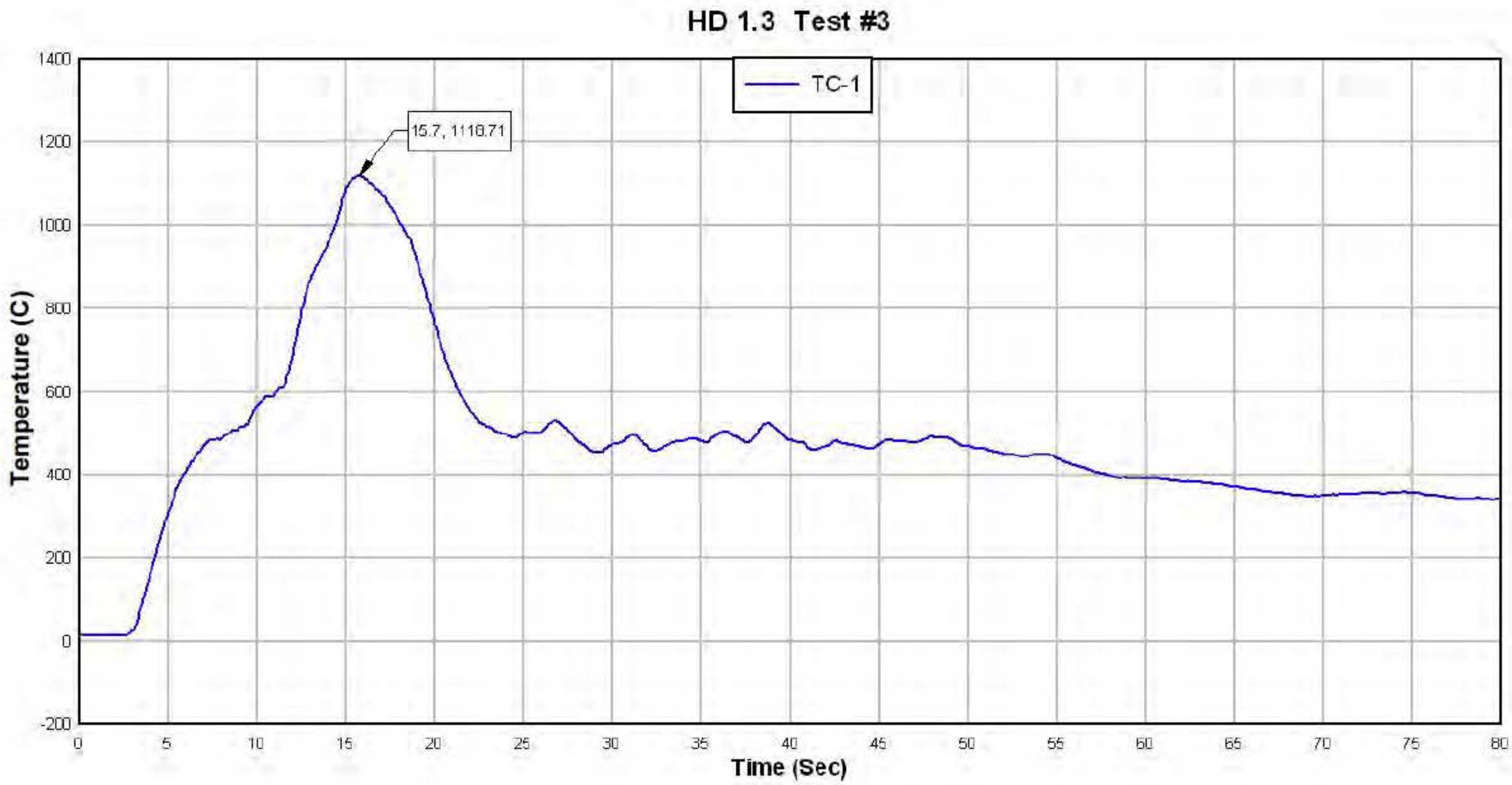

FIGURE IV-B-1. Thermocouple #1.

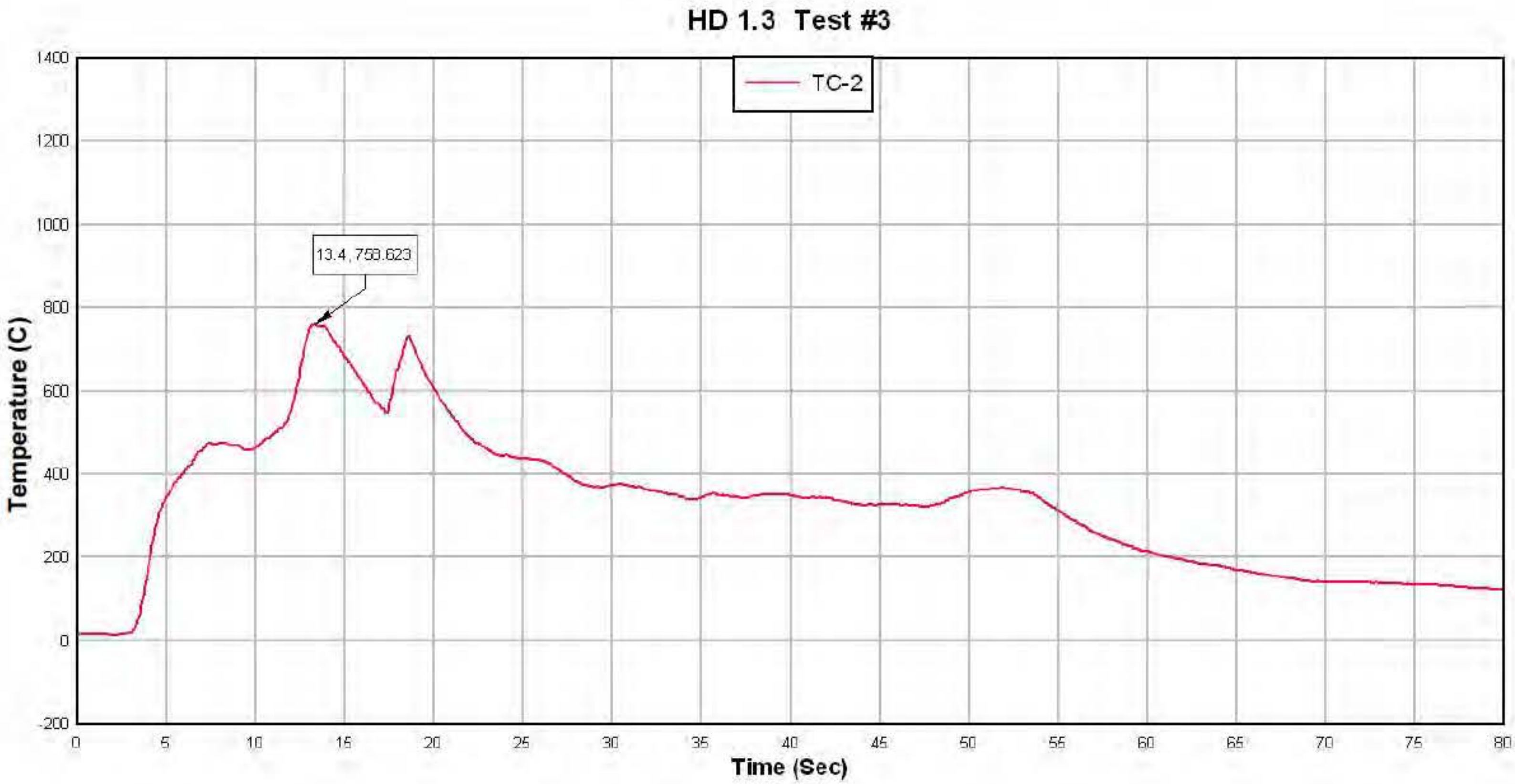

FIGURE IV-B-2. Thermocouple #2.

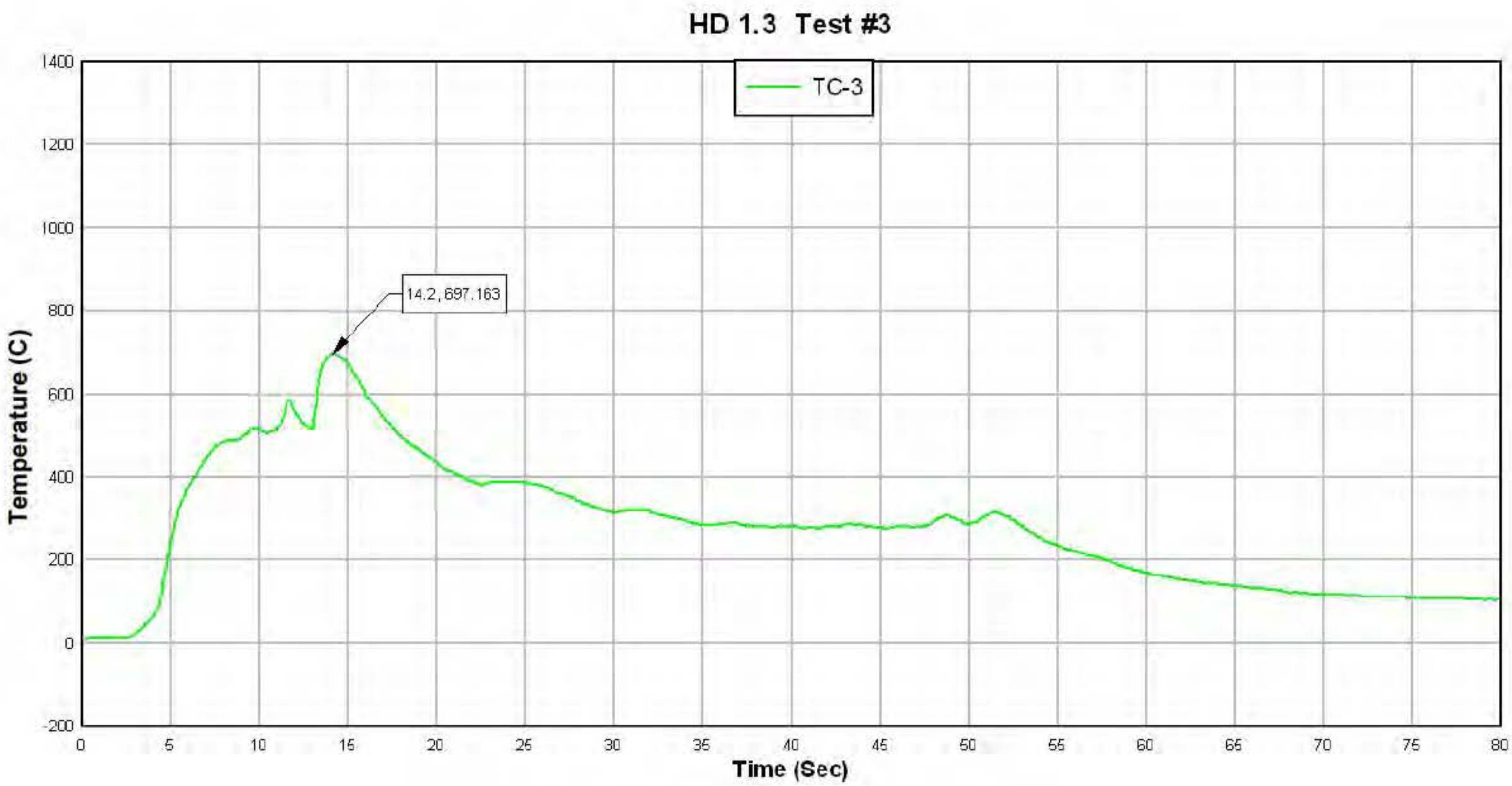

FIGURE IV-B-3. Thermocouple #3.

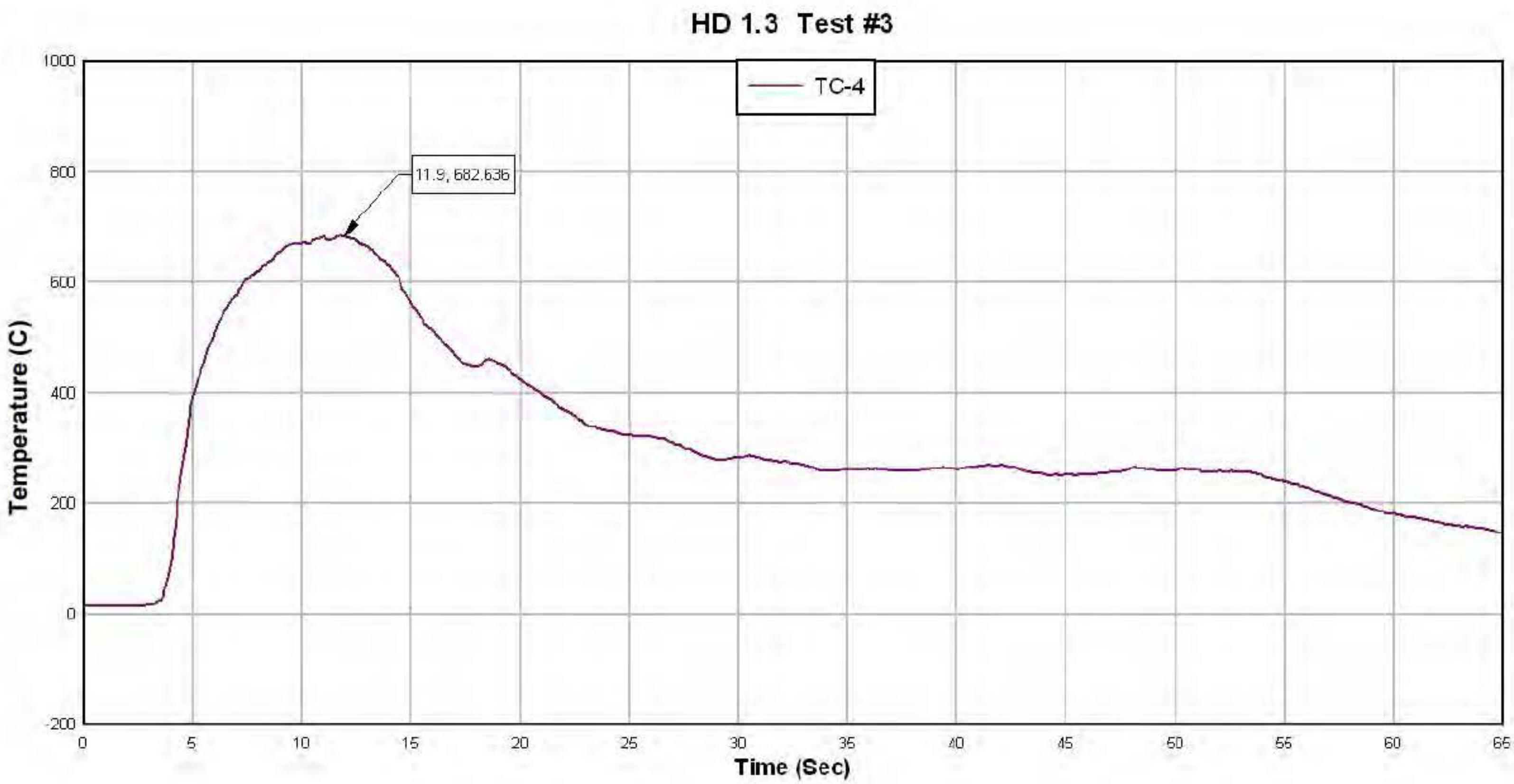

FIGURE IV-B-4. Thermocouple #4.

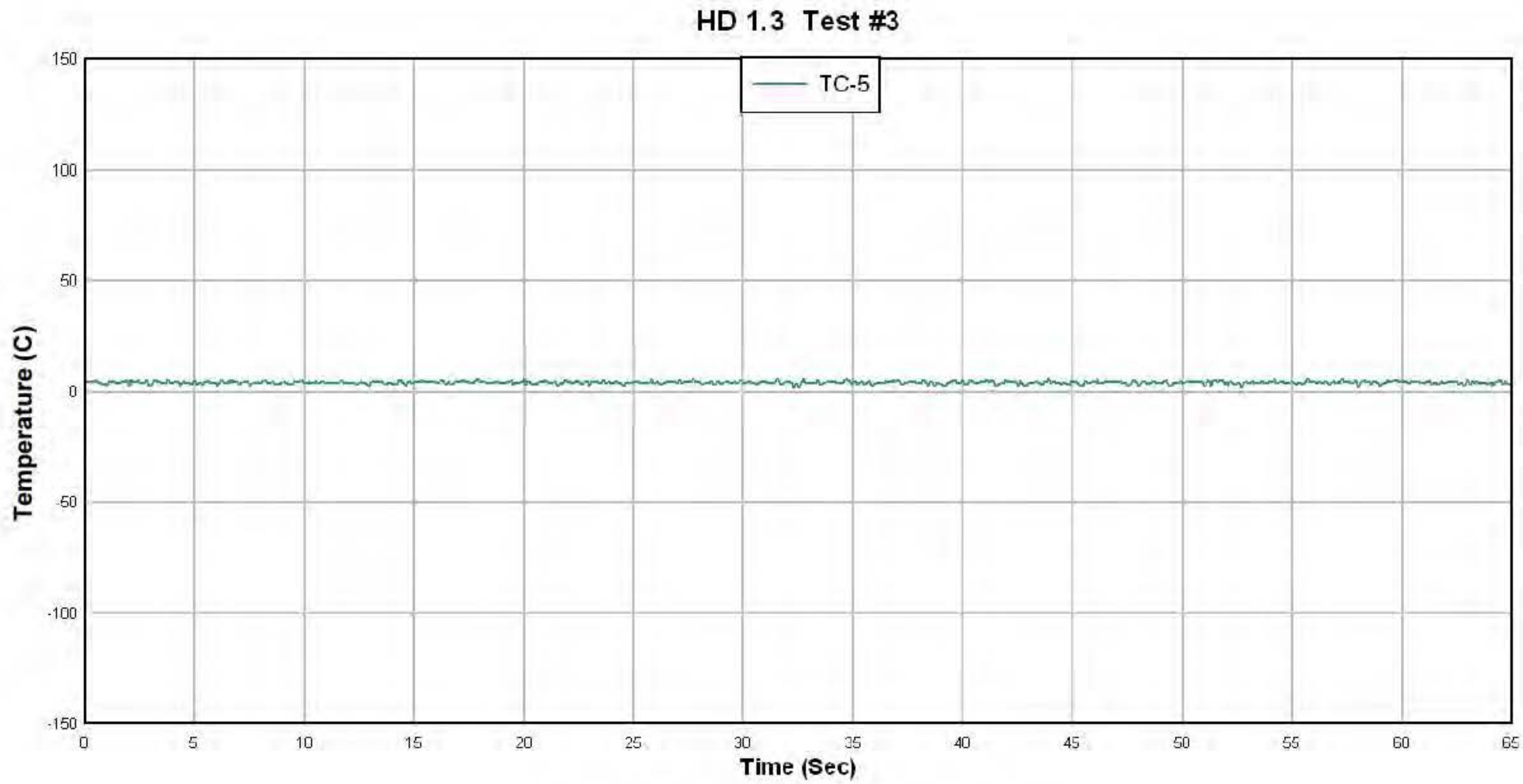

FIGURE IV-B-5. Thermocouple #5.

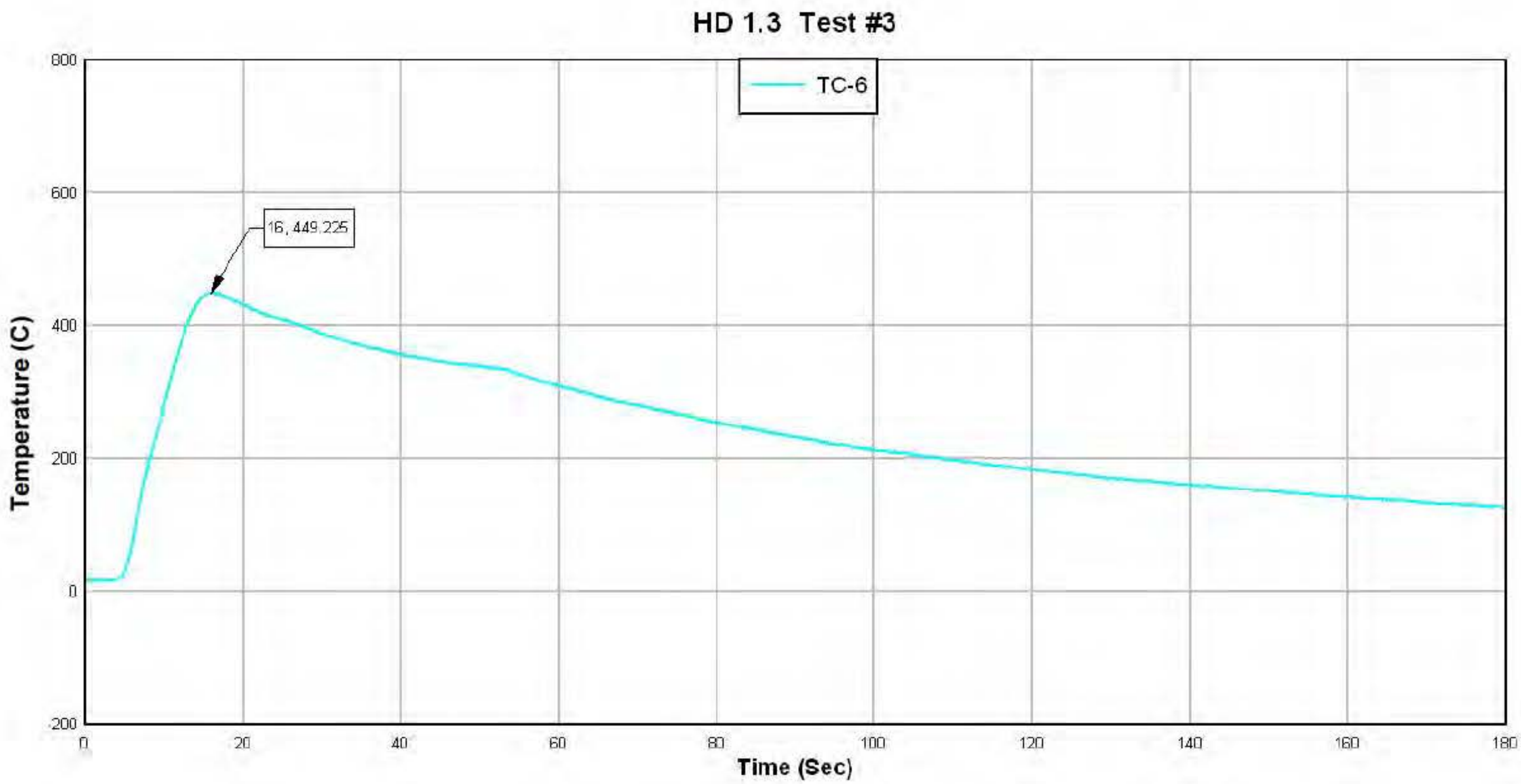

FIGURE IV-B-6. Thermocouple #6.

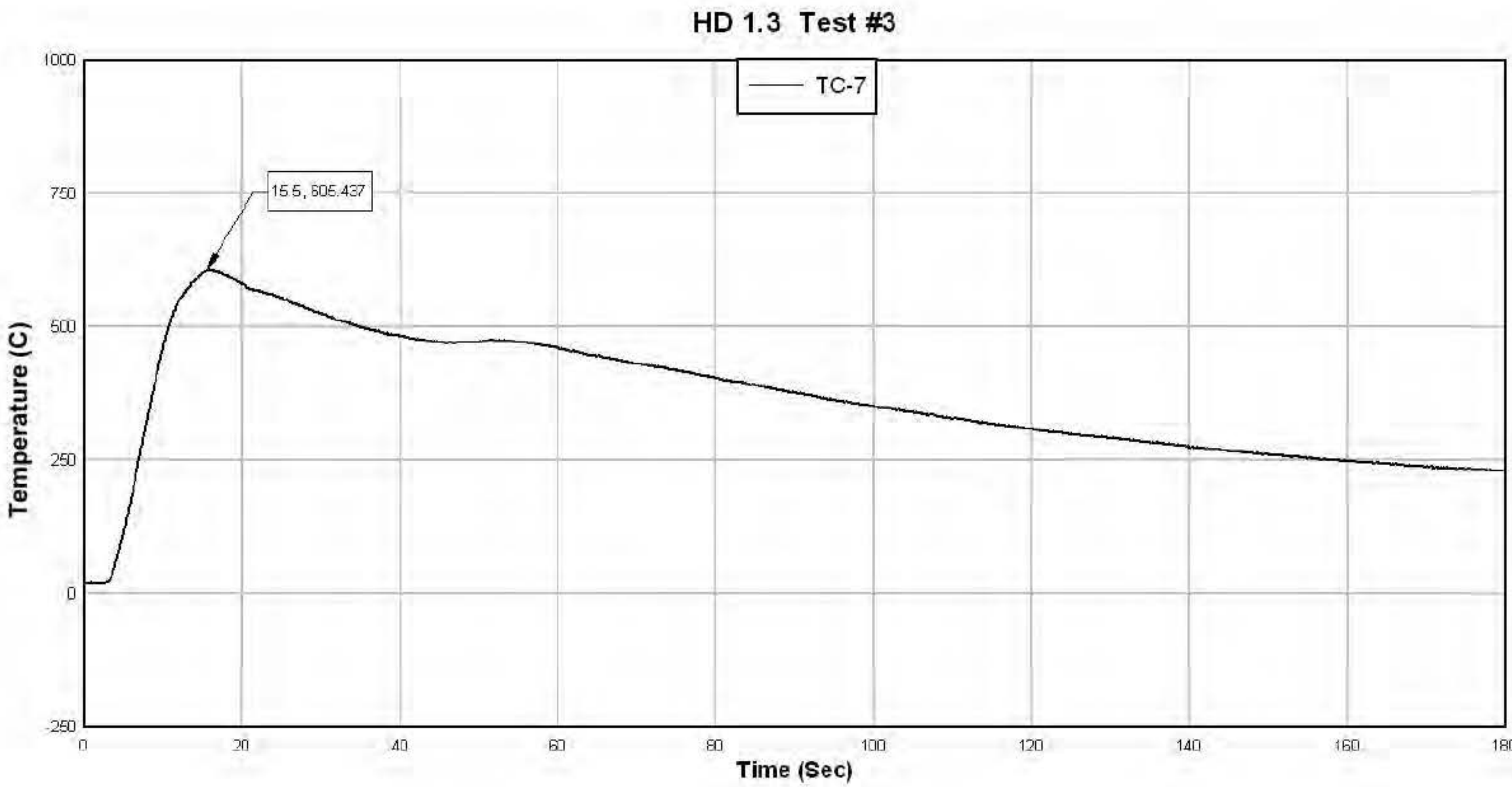

FIGURE IV-B-7. Thermocouple #7.

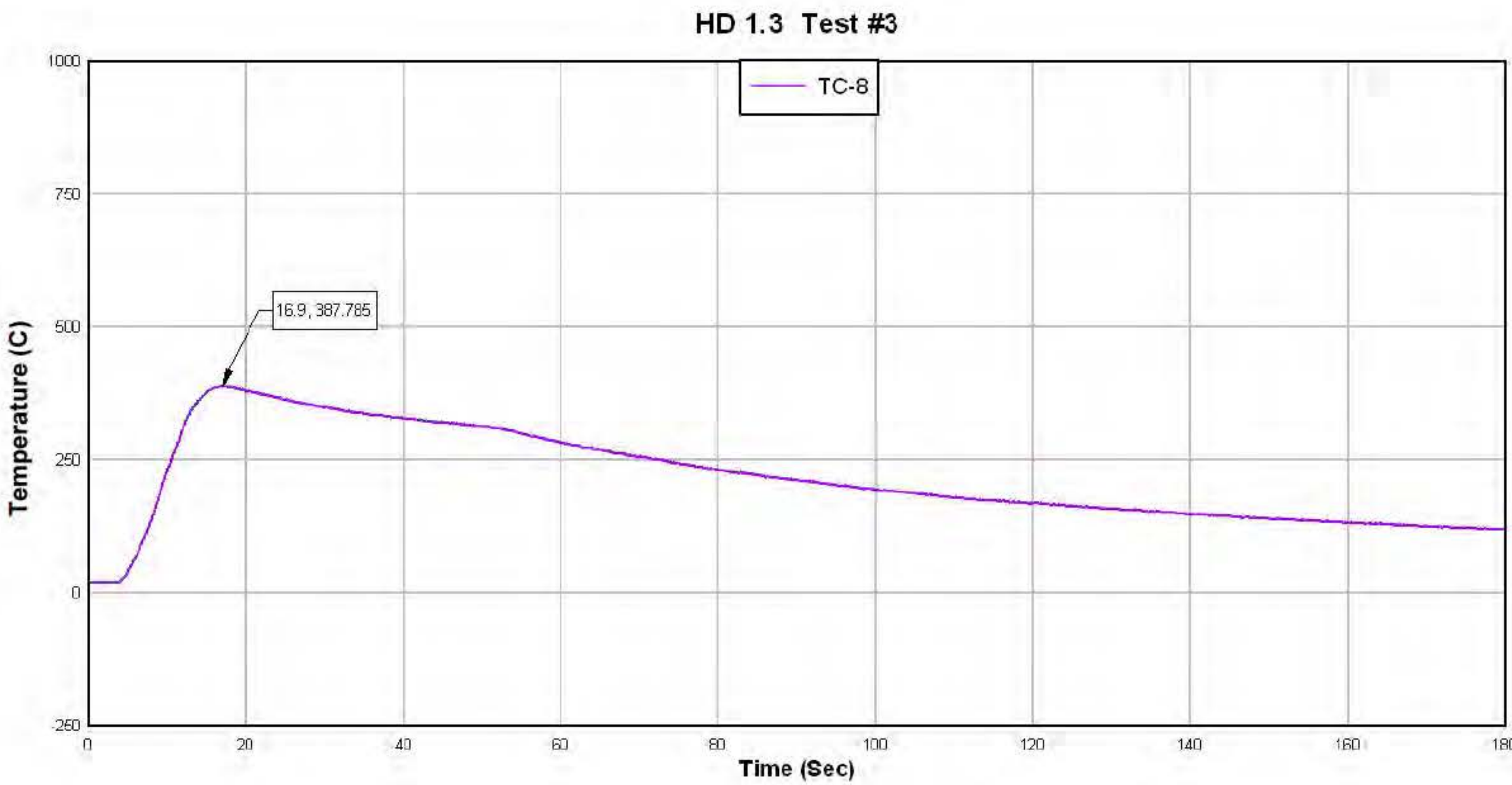

FIGURE IV-B-8. Thermocouple #8.

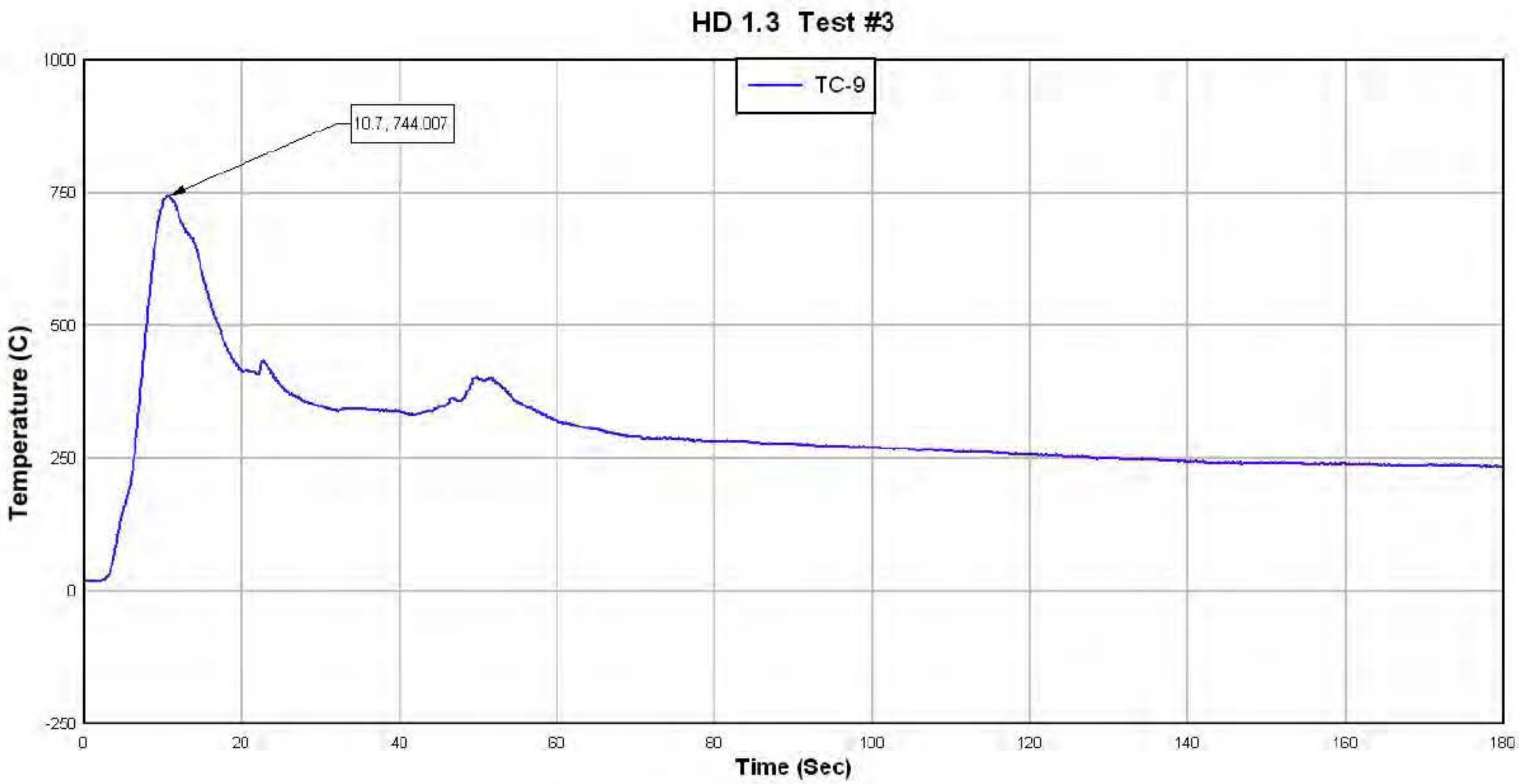

FIGURE IV-B-9. Thermocouple #9.

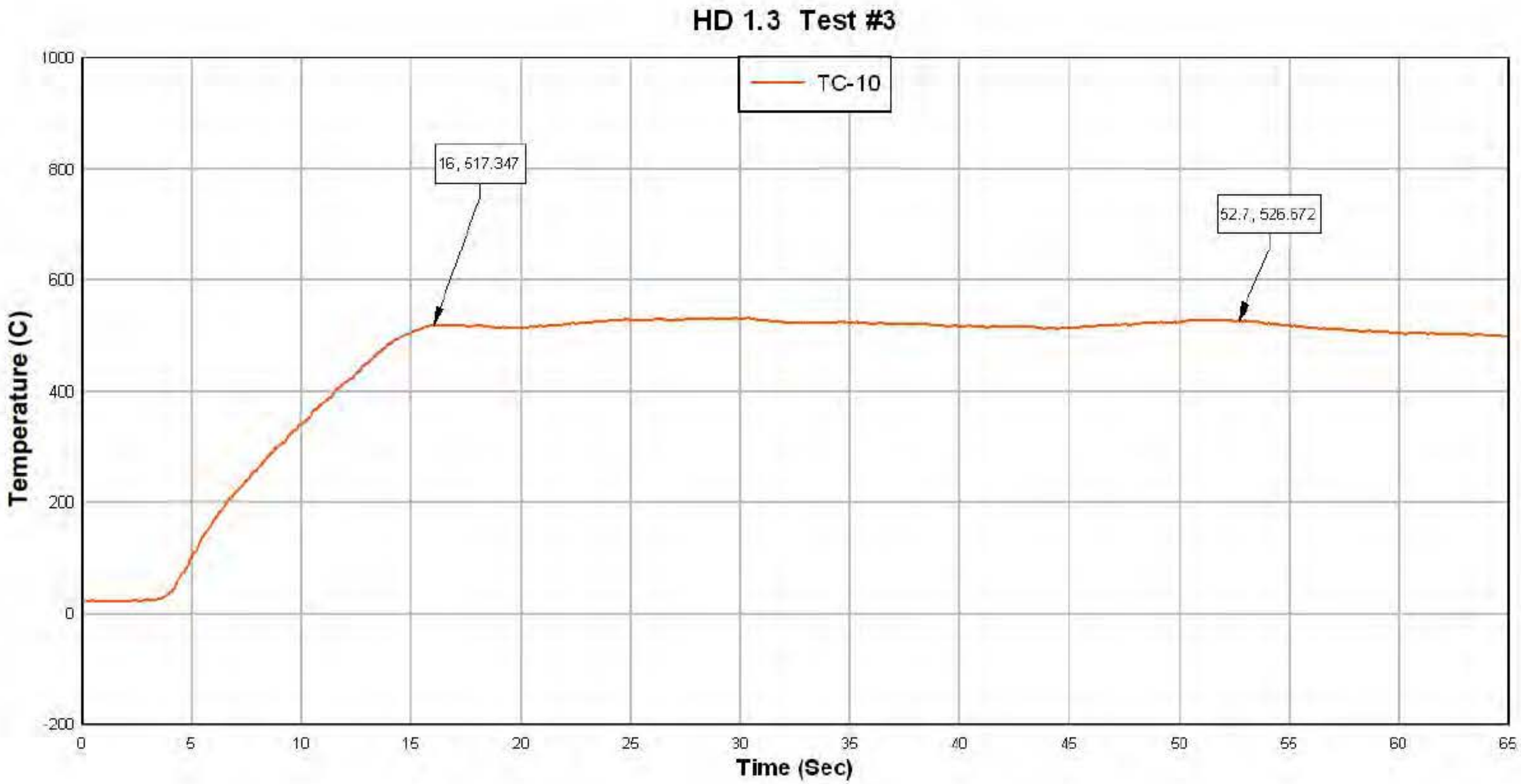

FIGURE IV-B-10. Thermocouple #10.

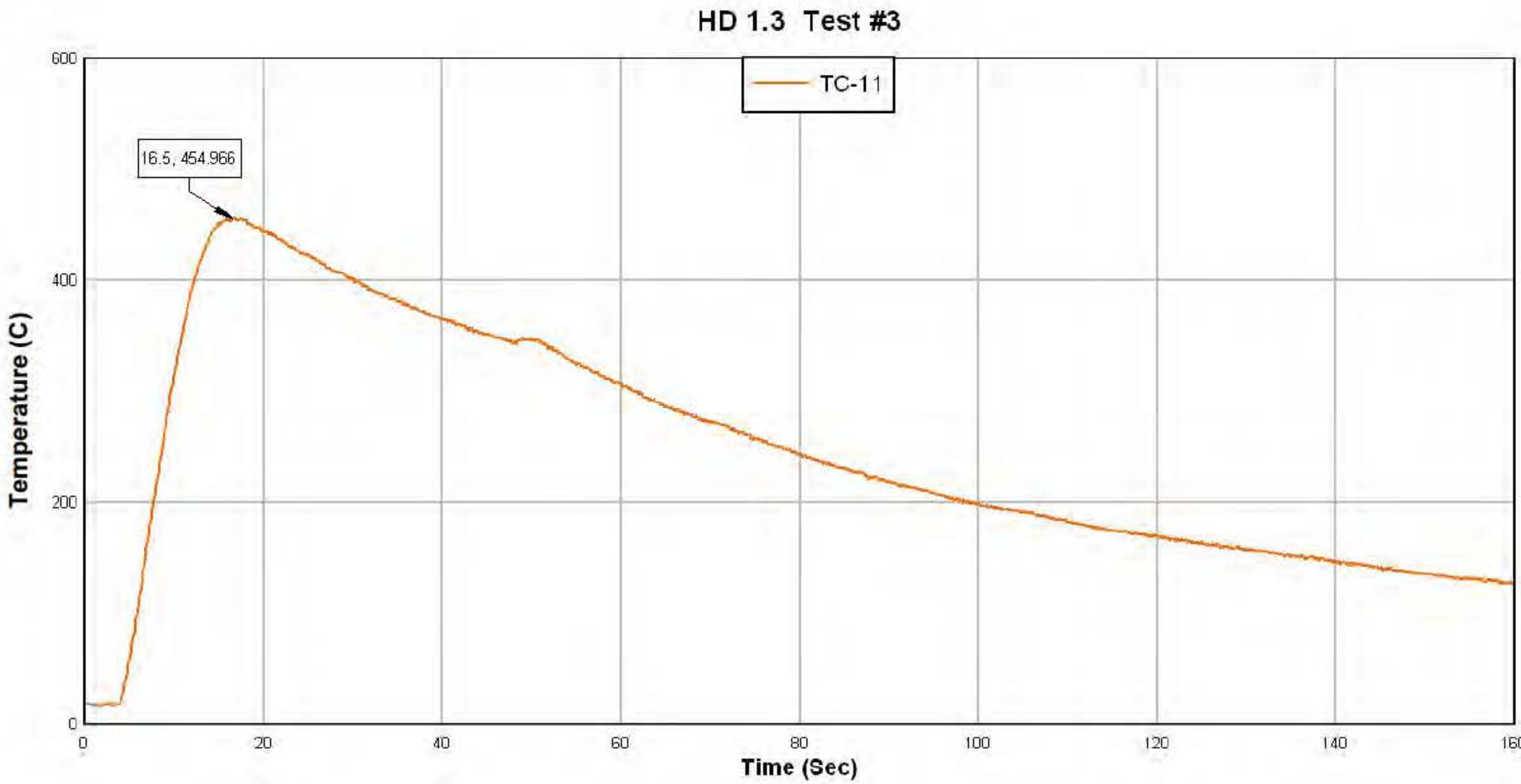

FIGURE IV-B-11. Thermocouple #11.

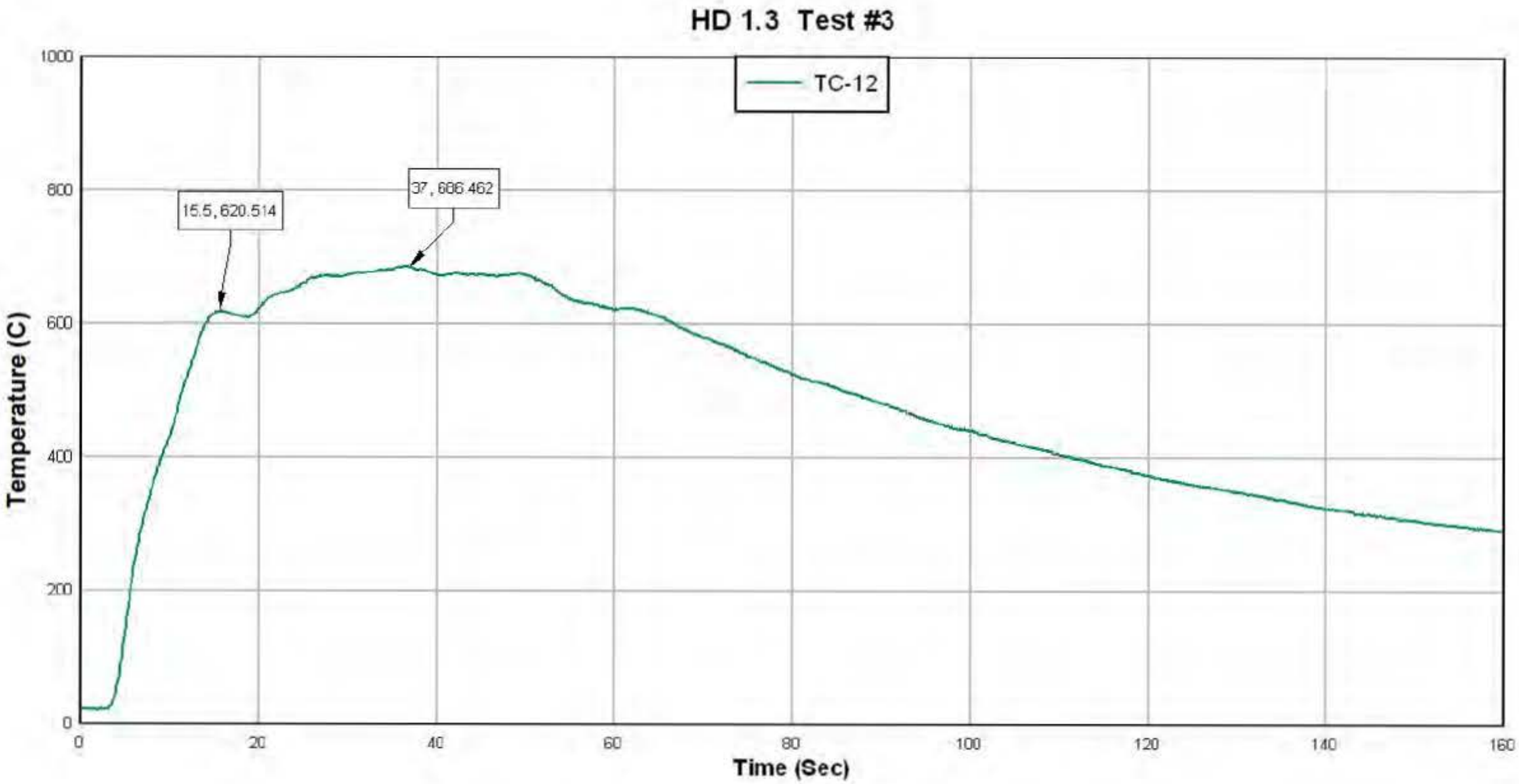

FIGURE IV-B-12. Thermocouple #12.

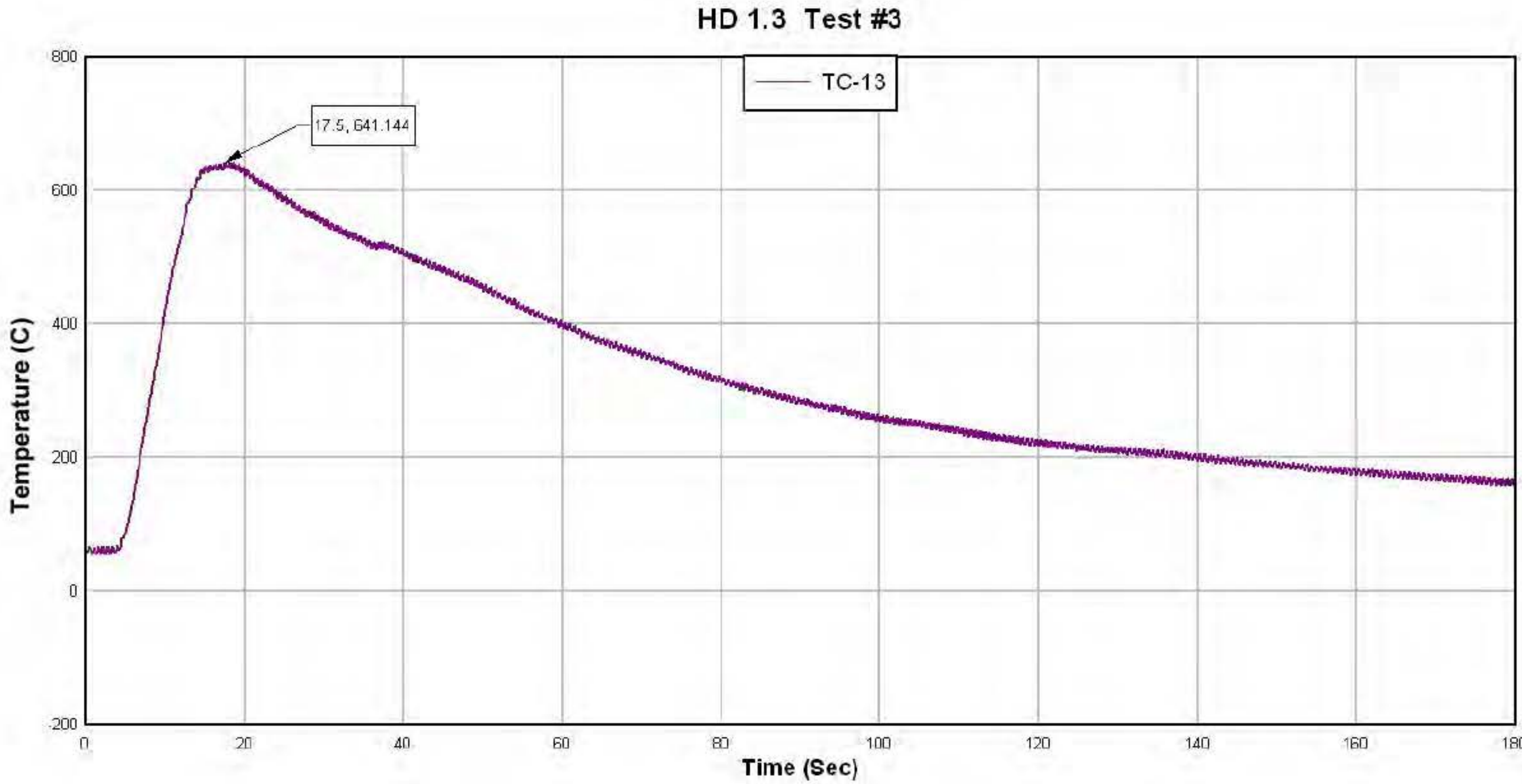

FIGURE IV-B-13. Thermocouple #13.

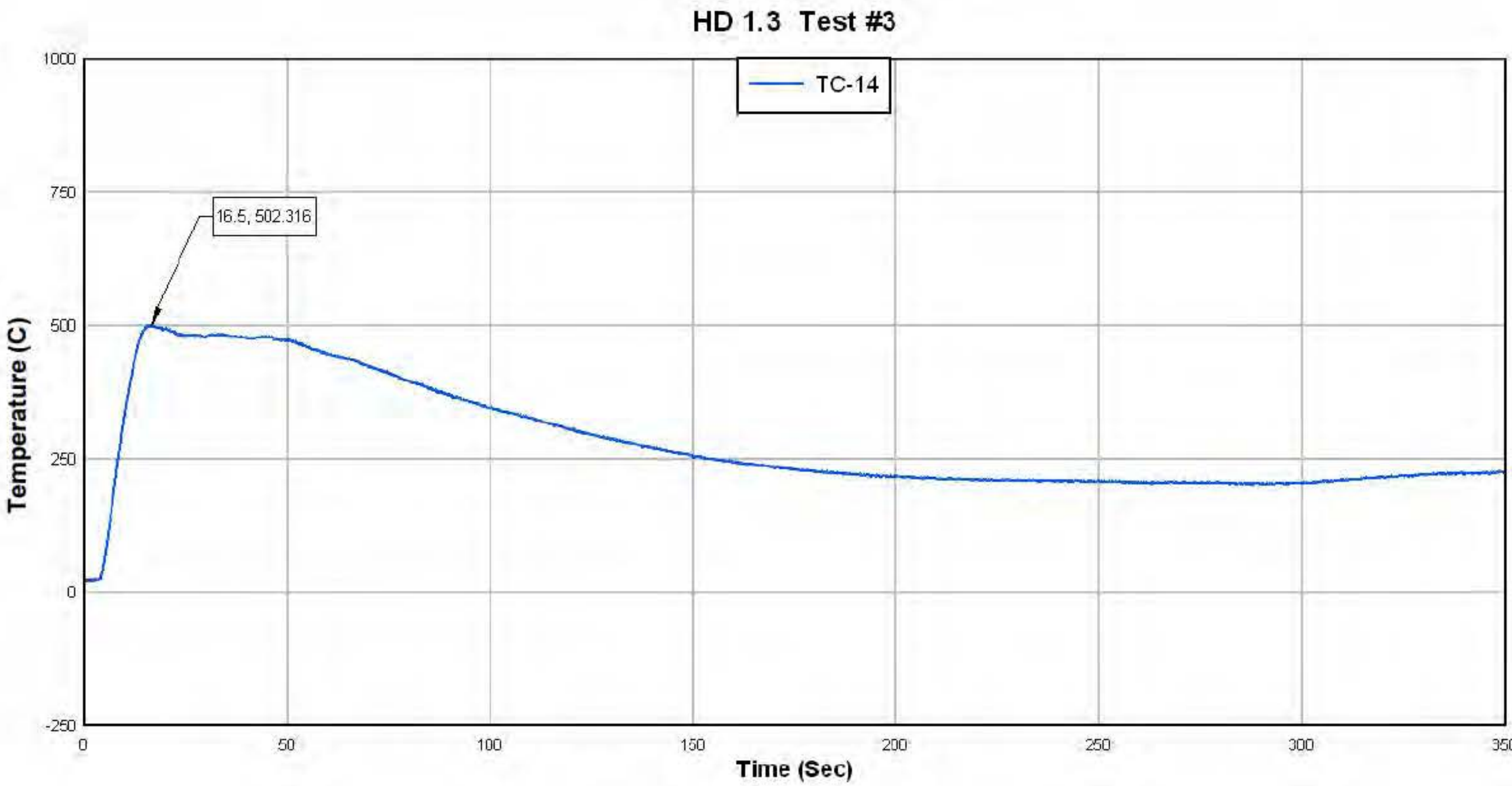

FIGURE IV-B-14. Thermocouple #14.

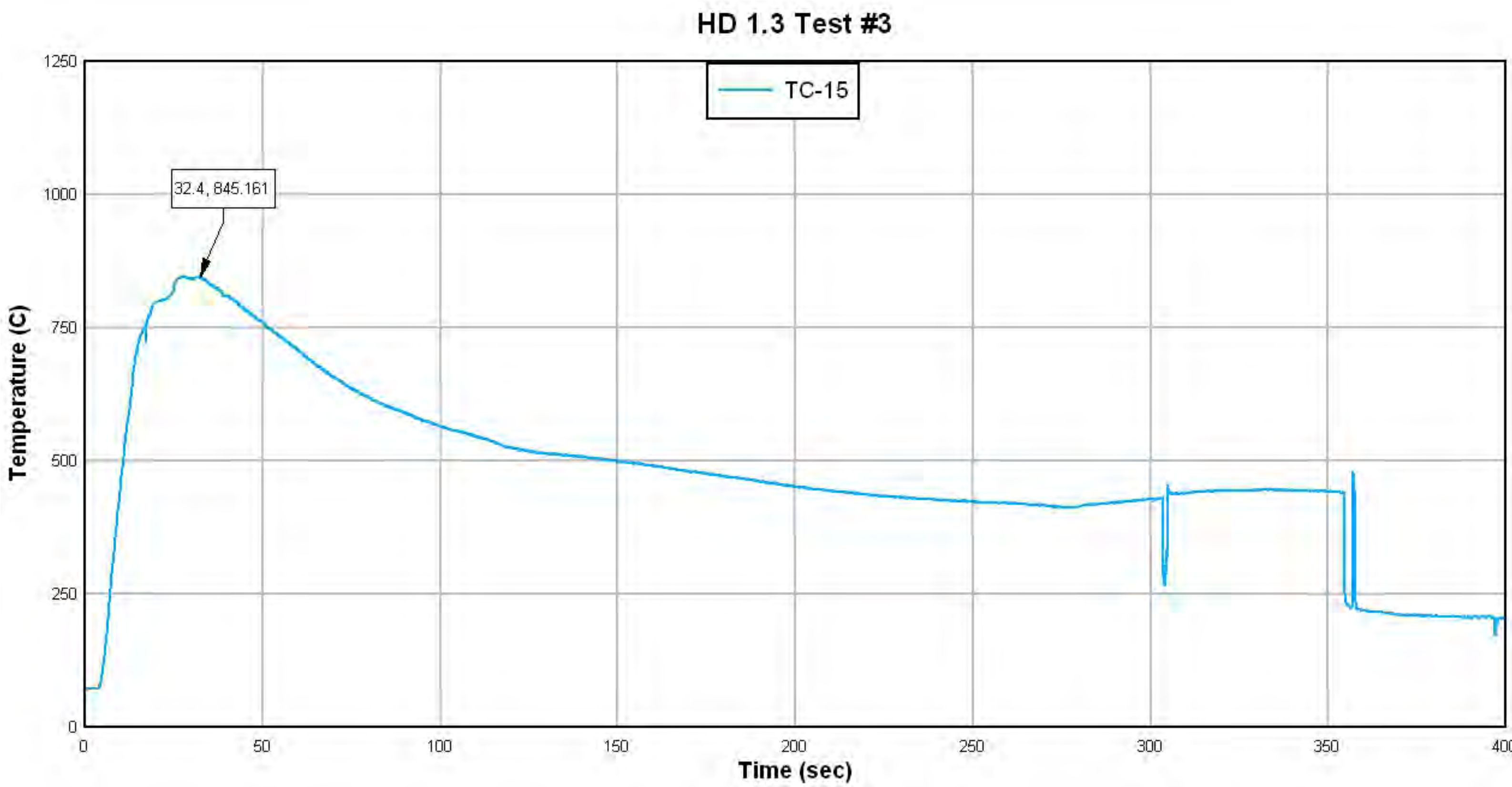

FIGURE IV-B-15. Thermocouple #15.

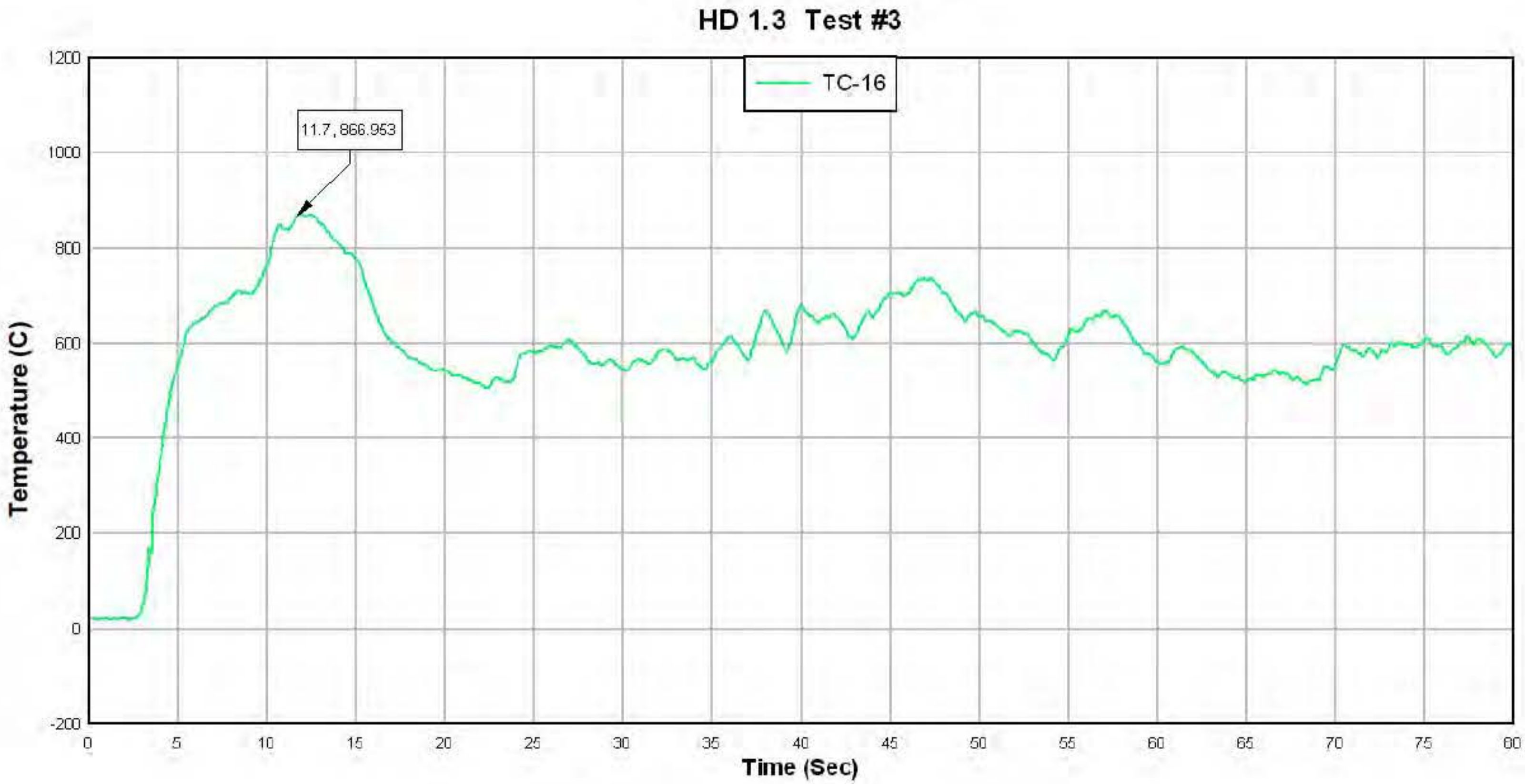

FIGURE IV-B-16. Thermocouple #16.

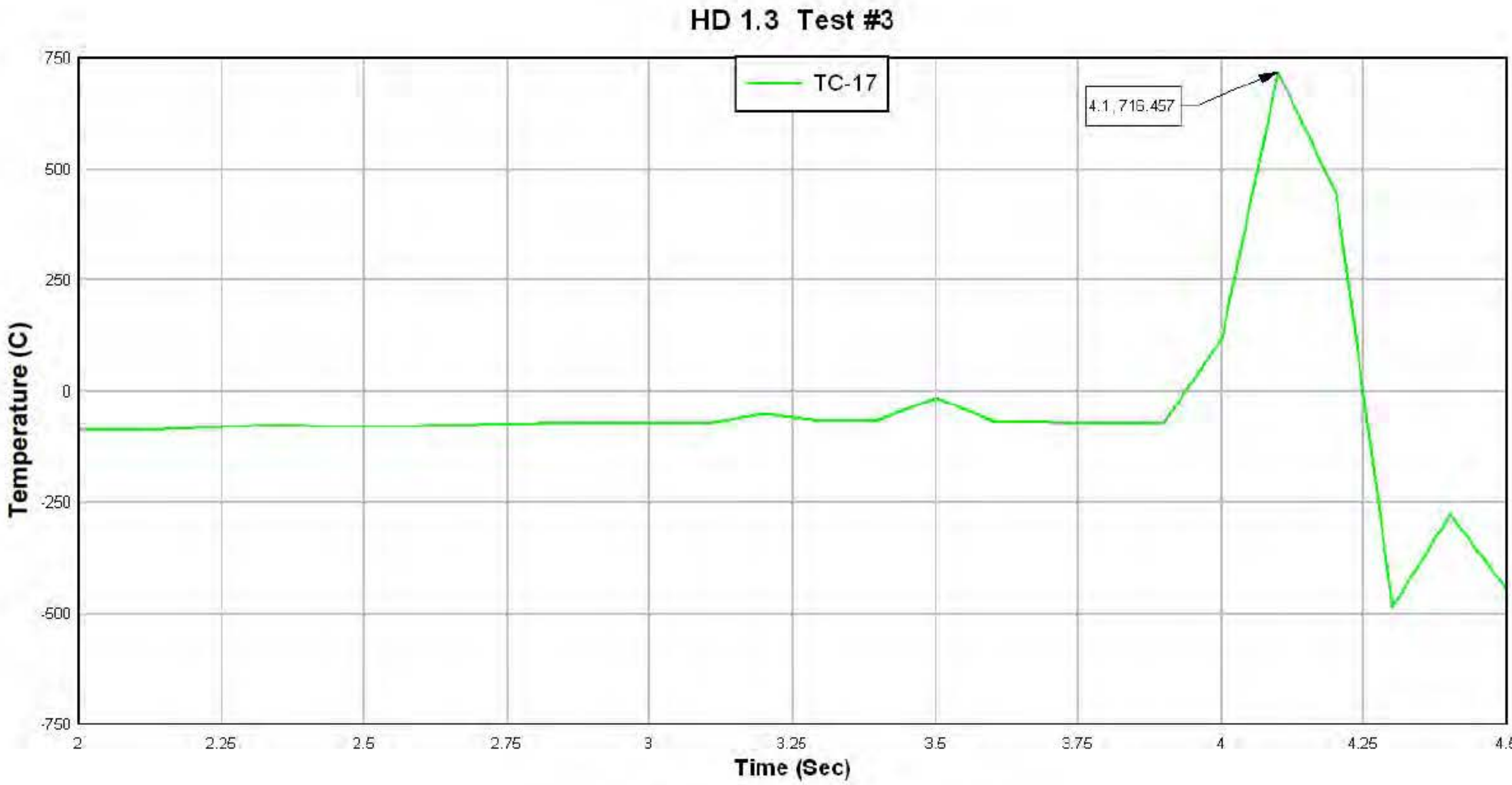

FIGURE IV-B-17. Thermocouple #17.

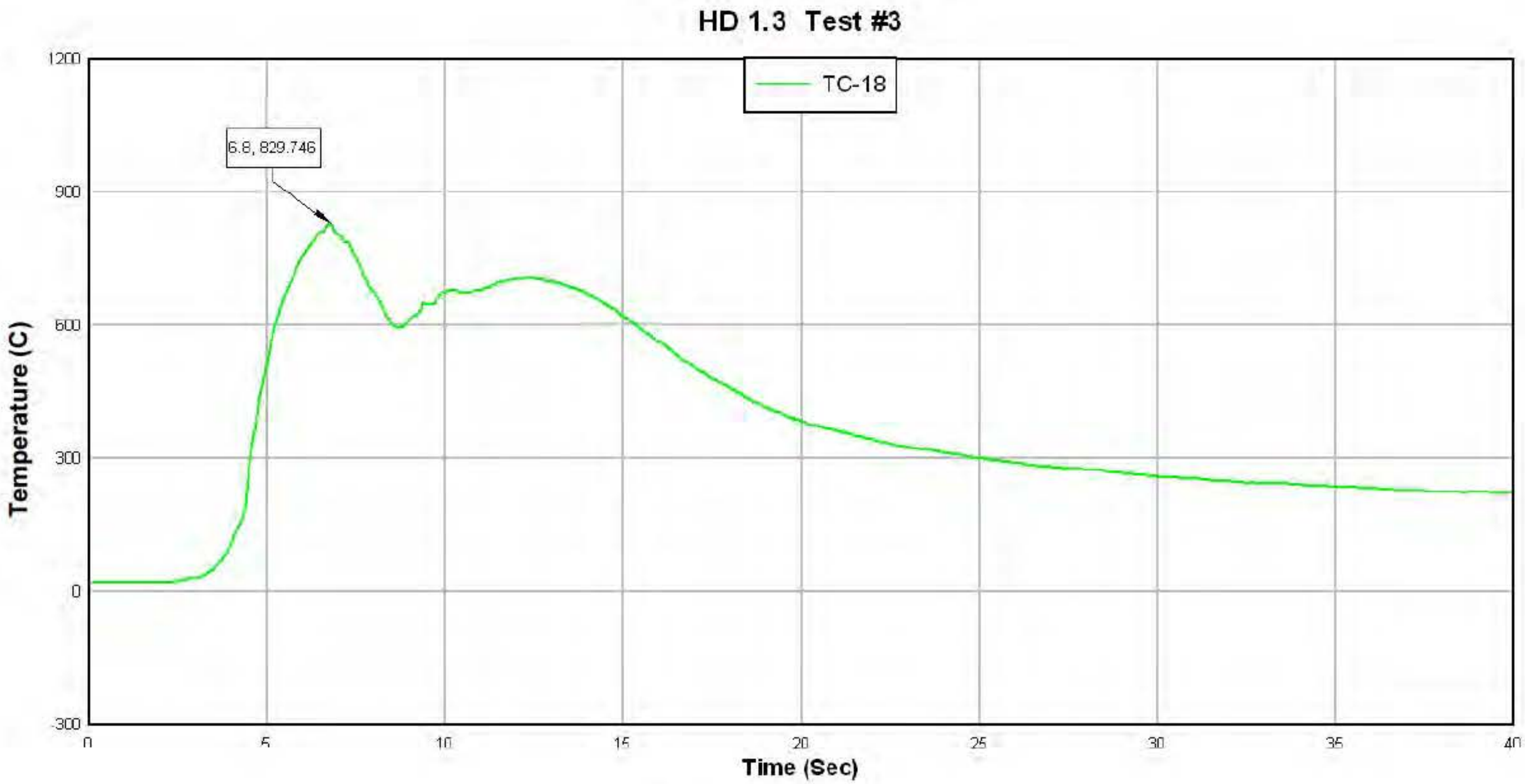

FIGURE IV-B-18. Thermocouple #18.

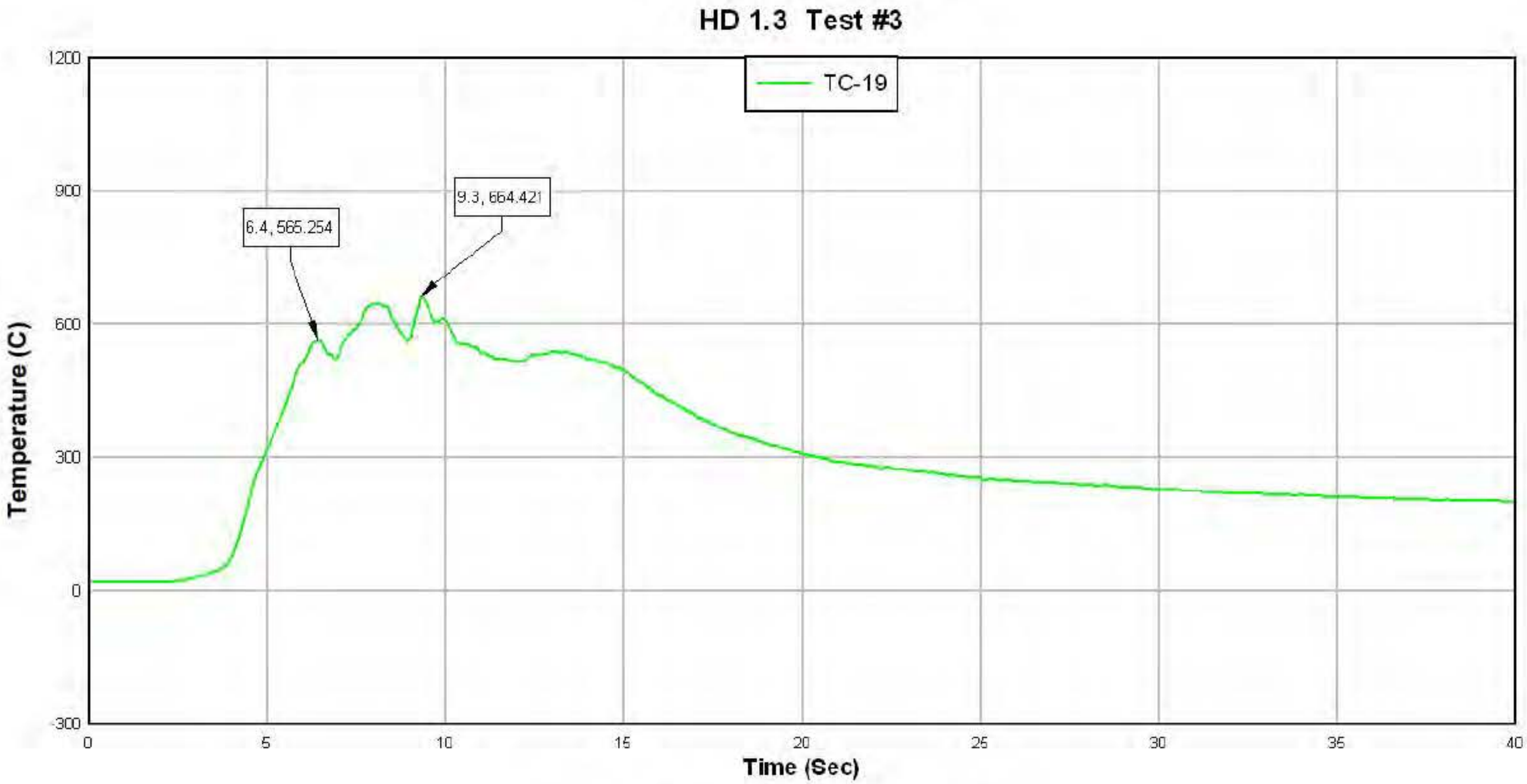

FIGURE IV-B-19. Thermocouple #19.

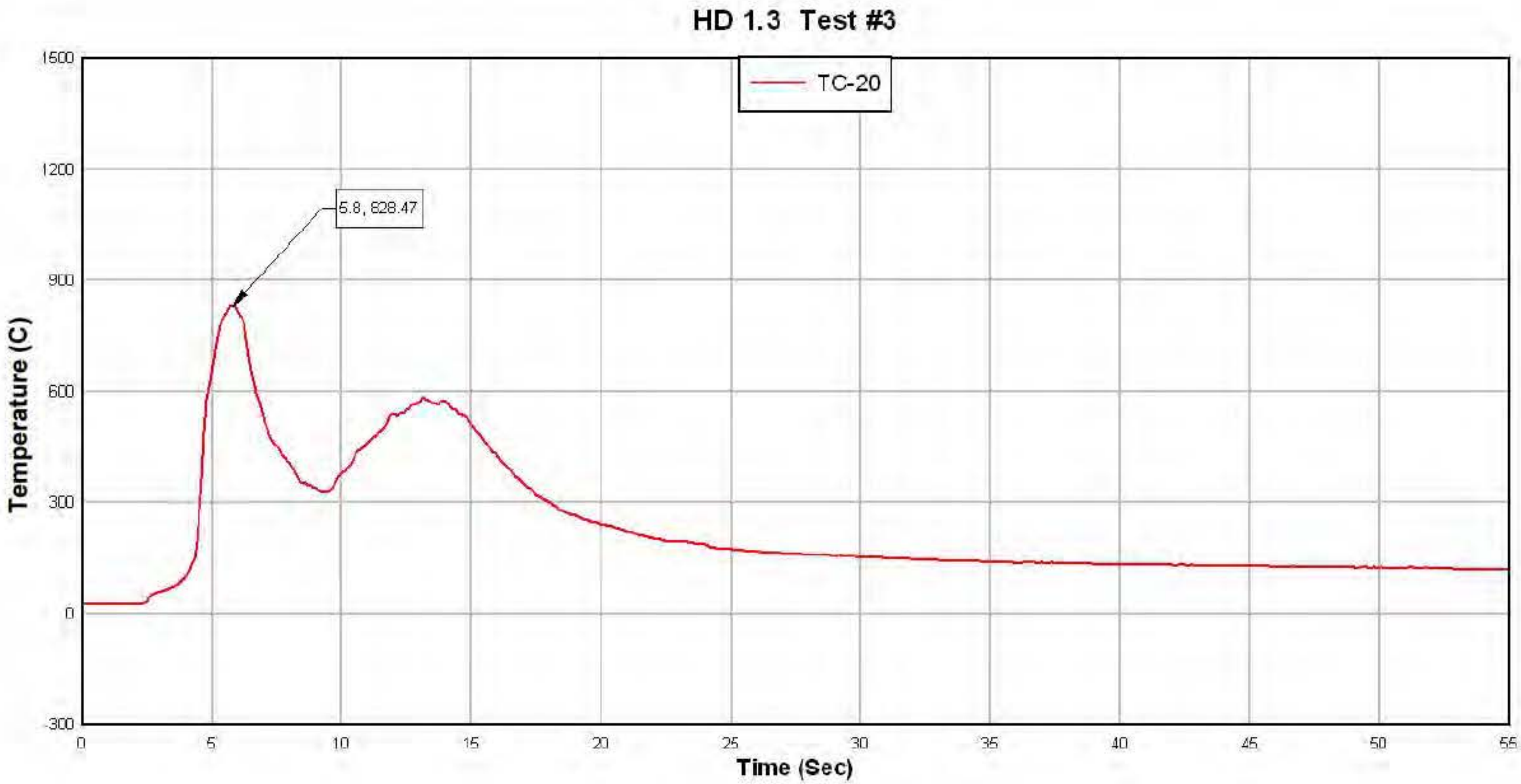

FIGURE IV-B-20. Thermocouple #20.

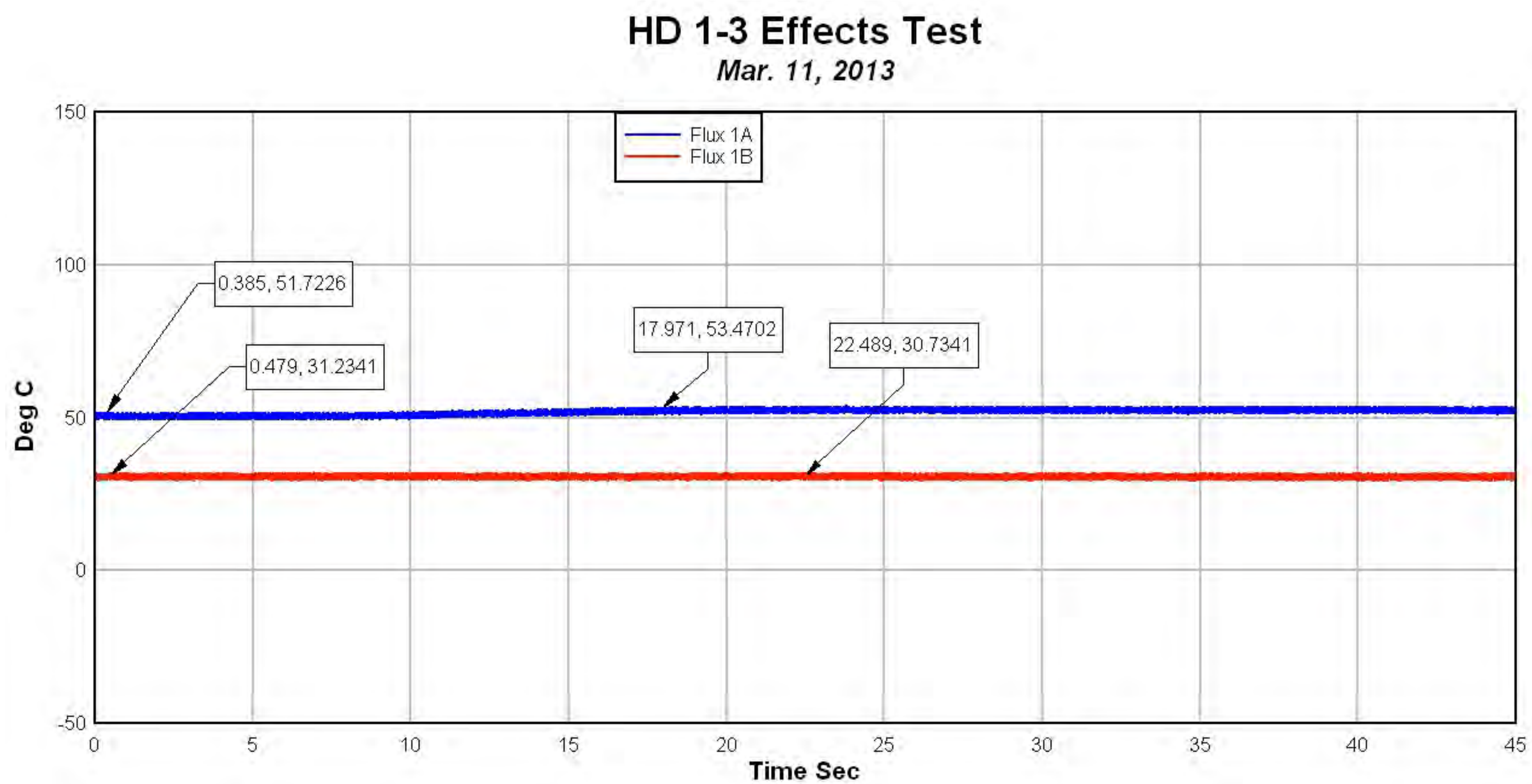

FIGURE IV-B-21. Flux Gage #1A and 1B (Outside).

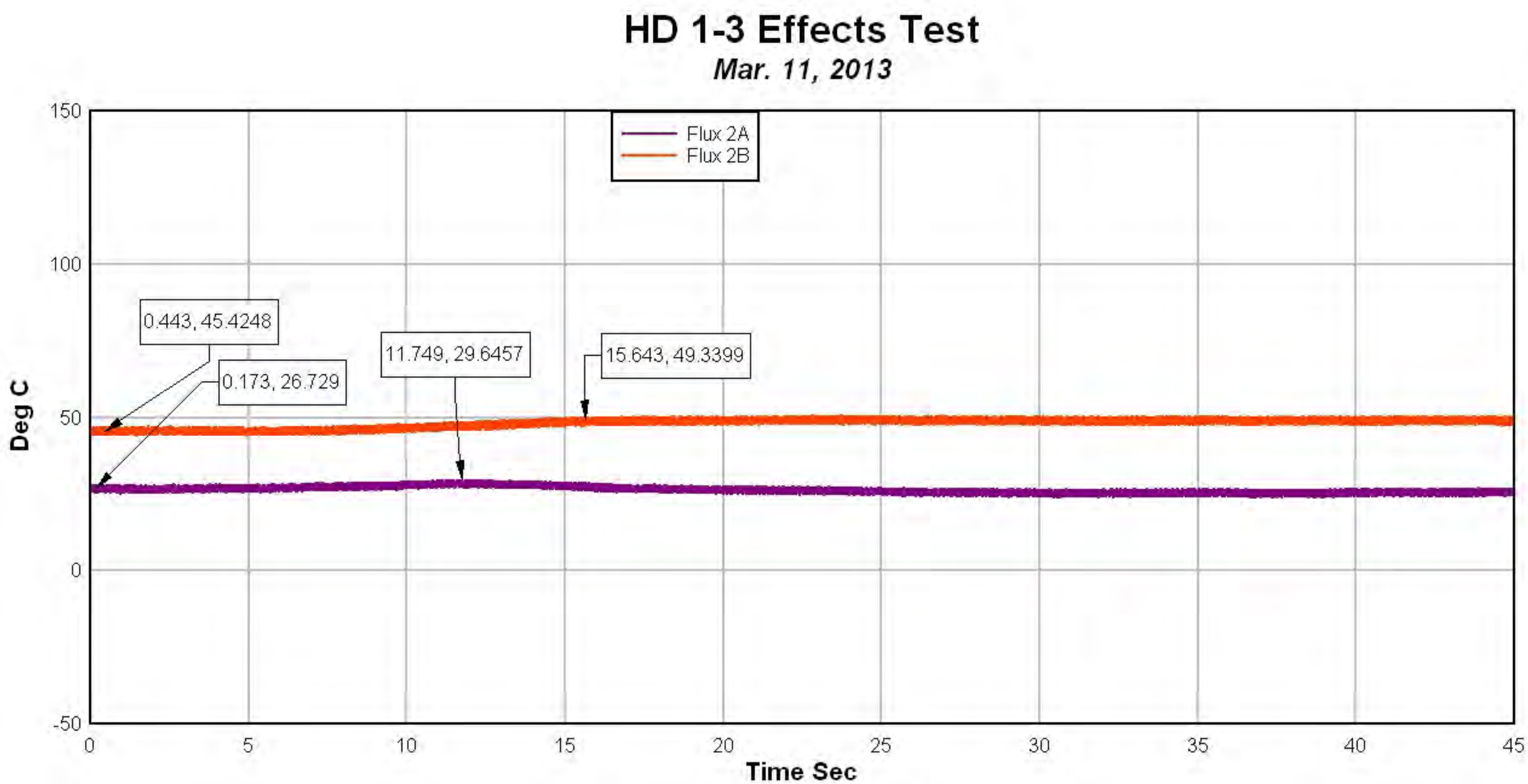

FIGURE IV-B-22. Flux Gage #2A and 2B (Outside).

FIGURE IV-B-23. Flux Gage #3A and 3B (Outside).

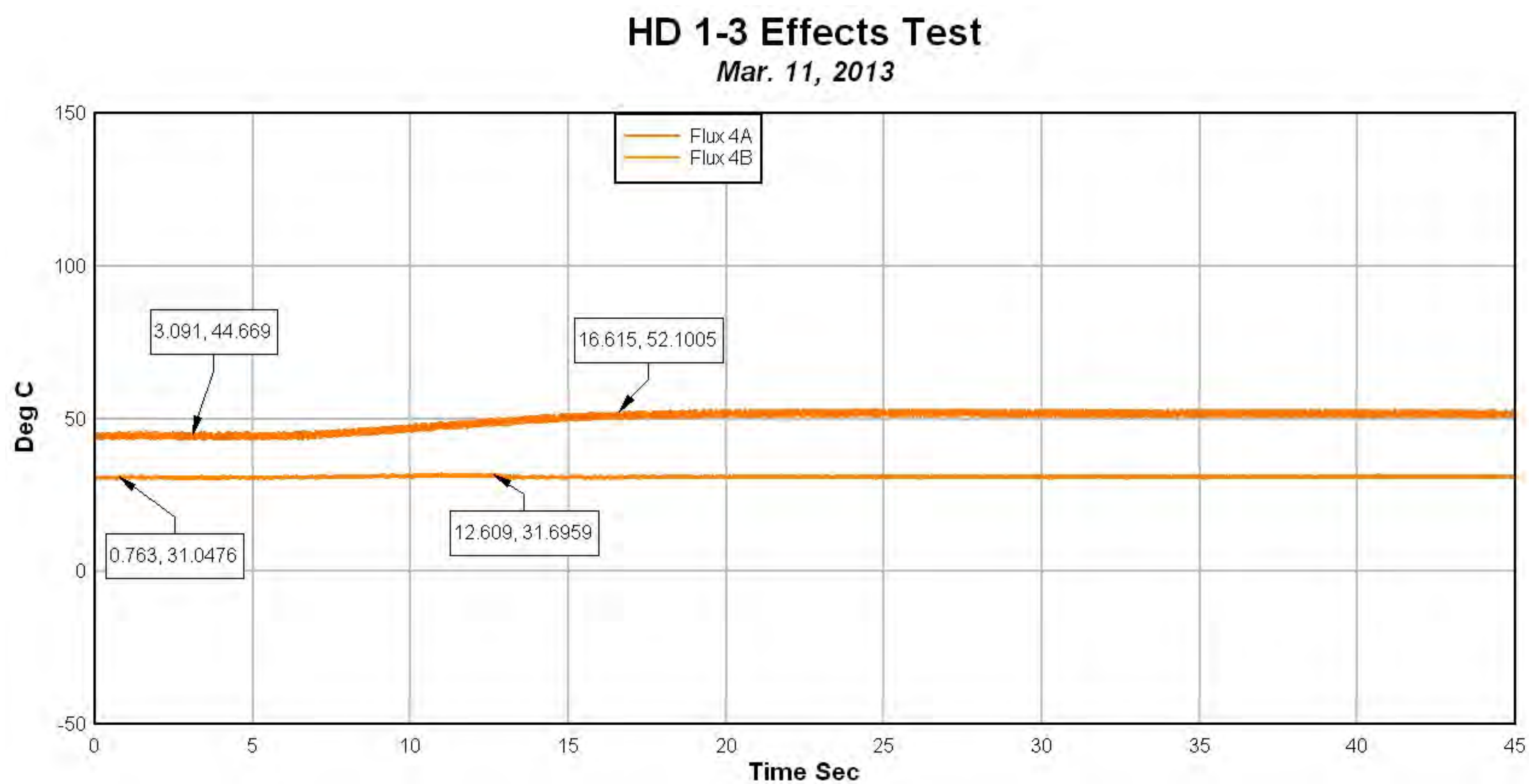

FIGURE IV-B-24. Flux Gage #4A and 4B (Outside).

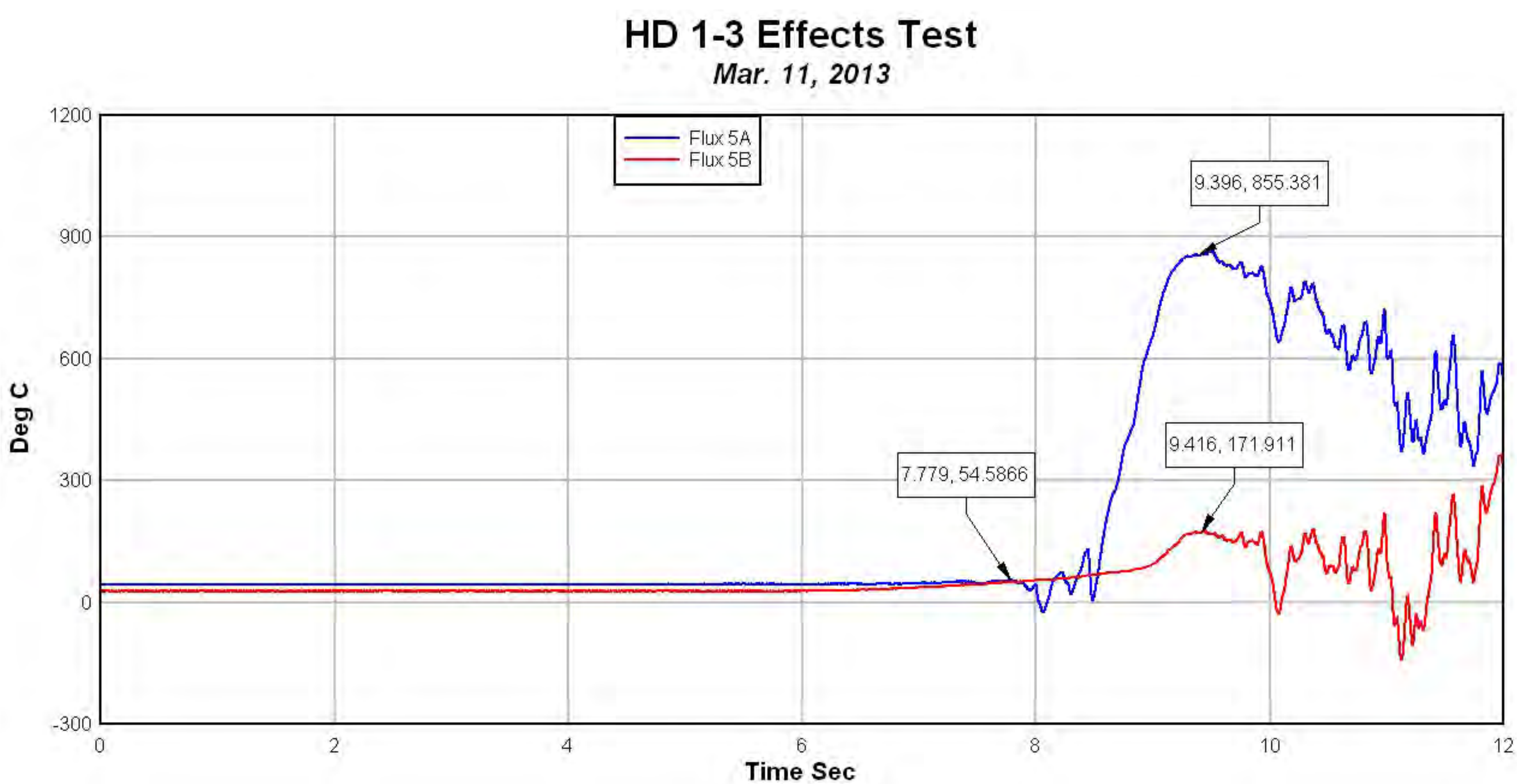

FIGURE IV-B-25. Flux Gage #5A and 5B (Outside).

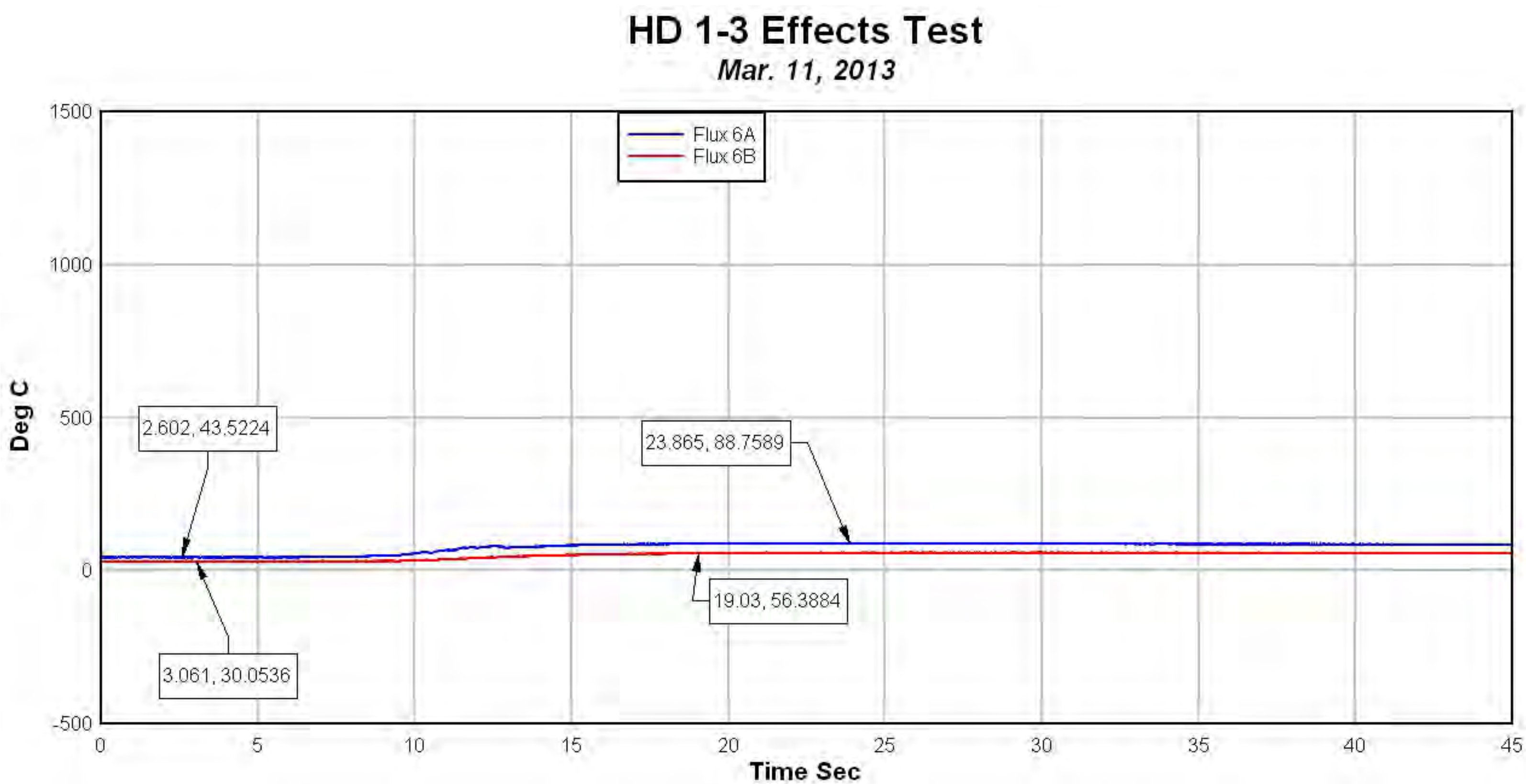

FIGURE IV-B-26. Flux Gage #6A and 6B (Outside).

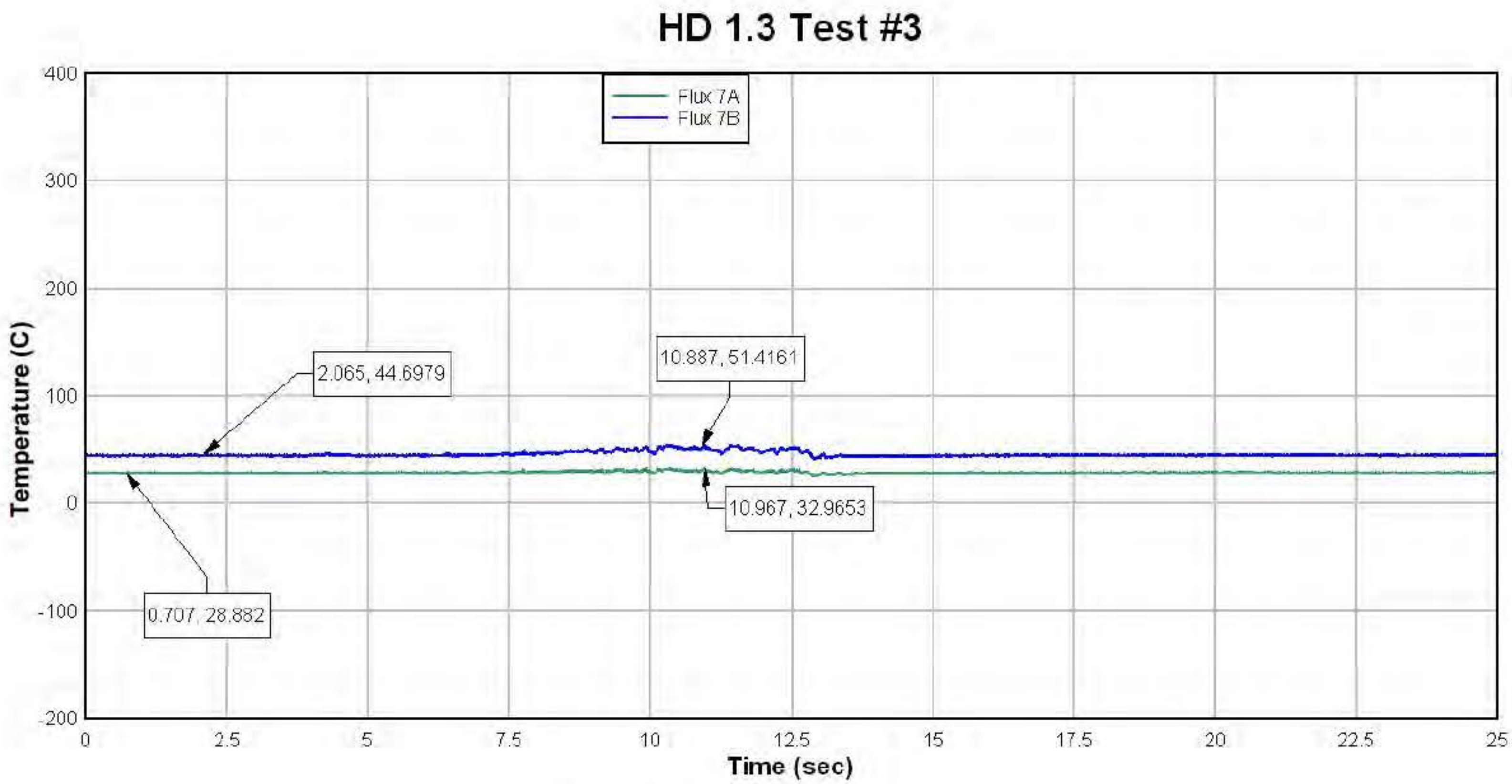

FIGURE IV-B-27. Flux Gage #7A and 7B (Outside).

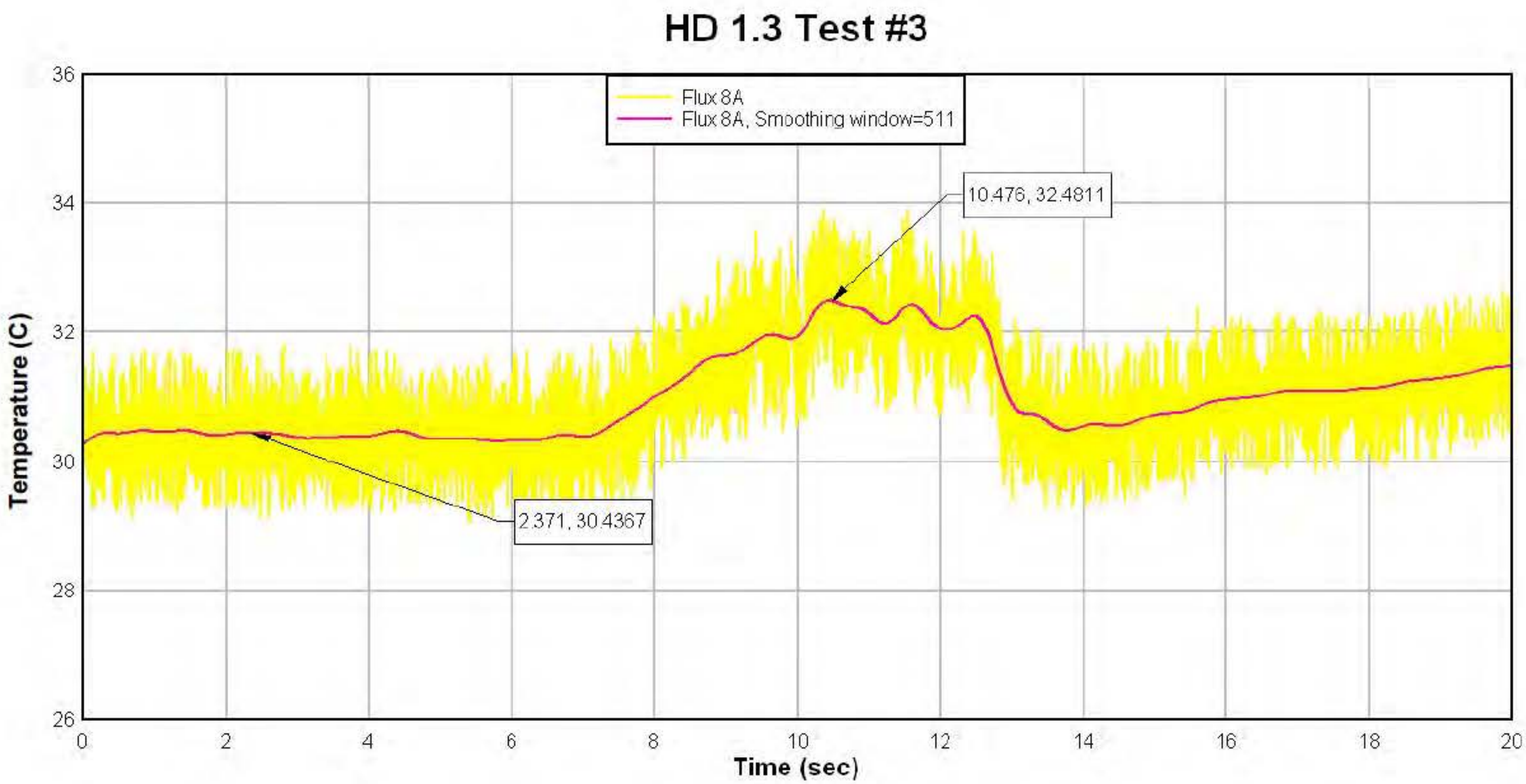

FIGURE IV-B-28. Flux Gage #8A (Outside).

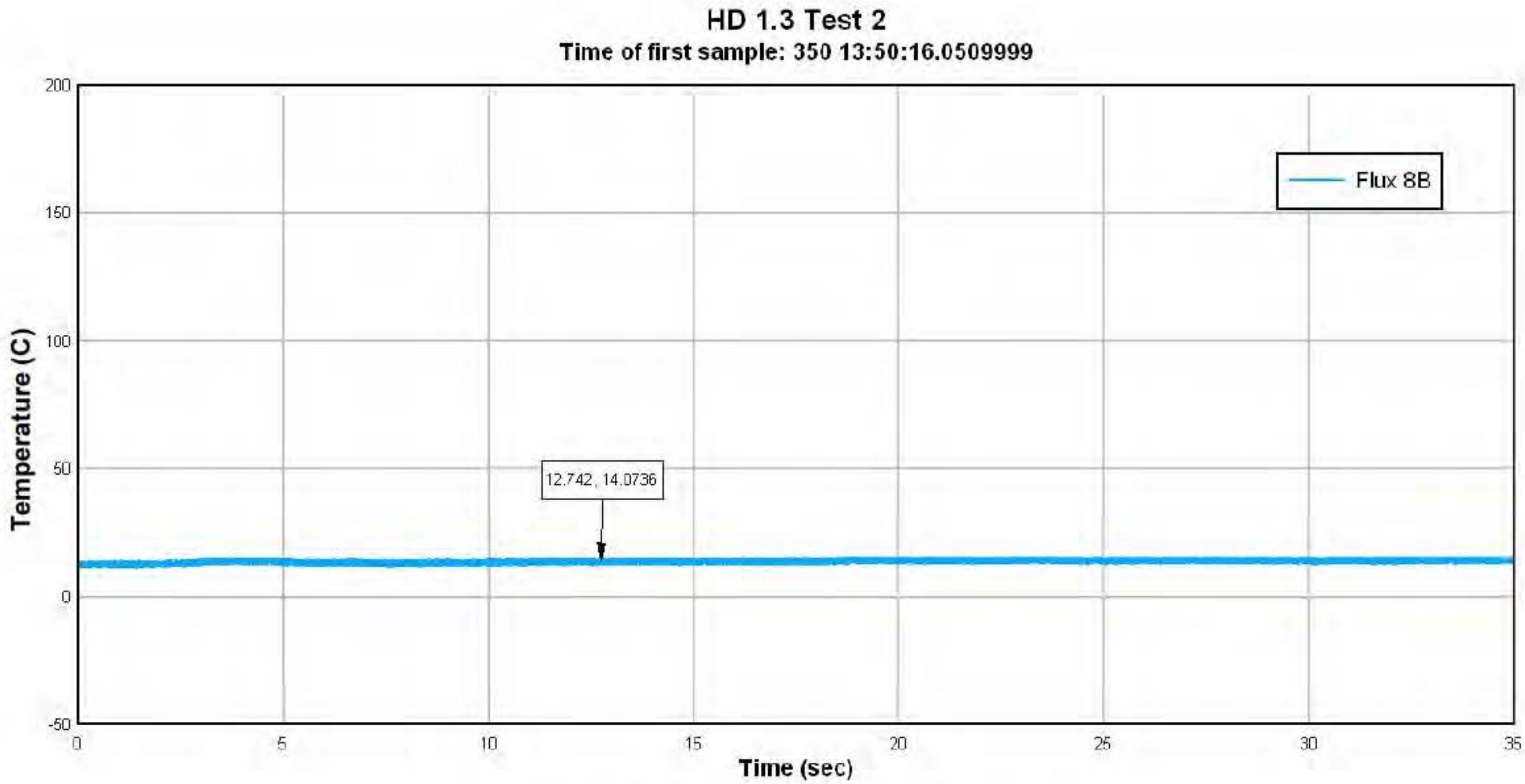

FIGURE IV-B-29. Flux Gage #8B (Outside).

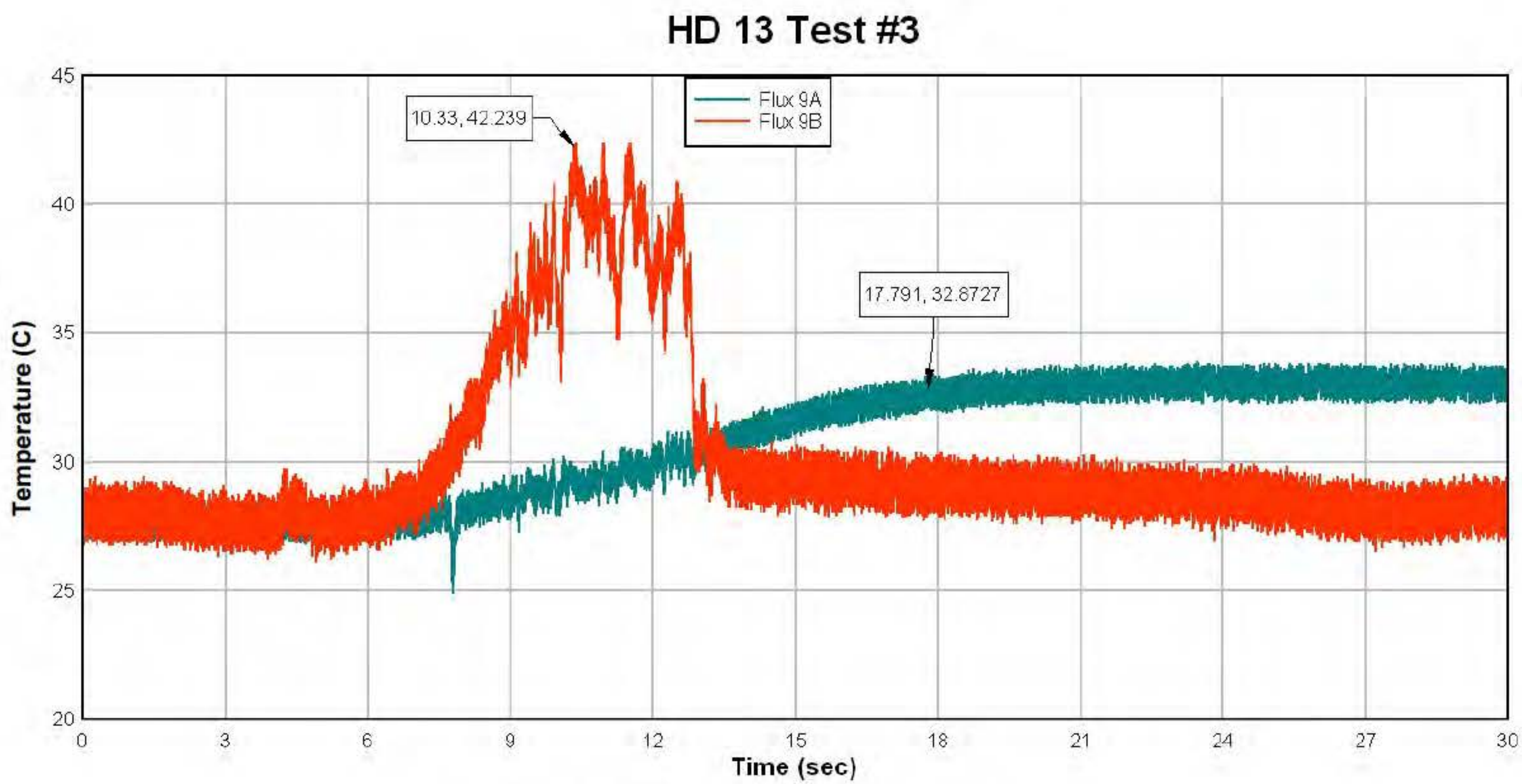

FIGURE IV-B-30. Flux Gage #9A and 9B (Outside).

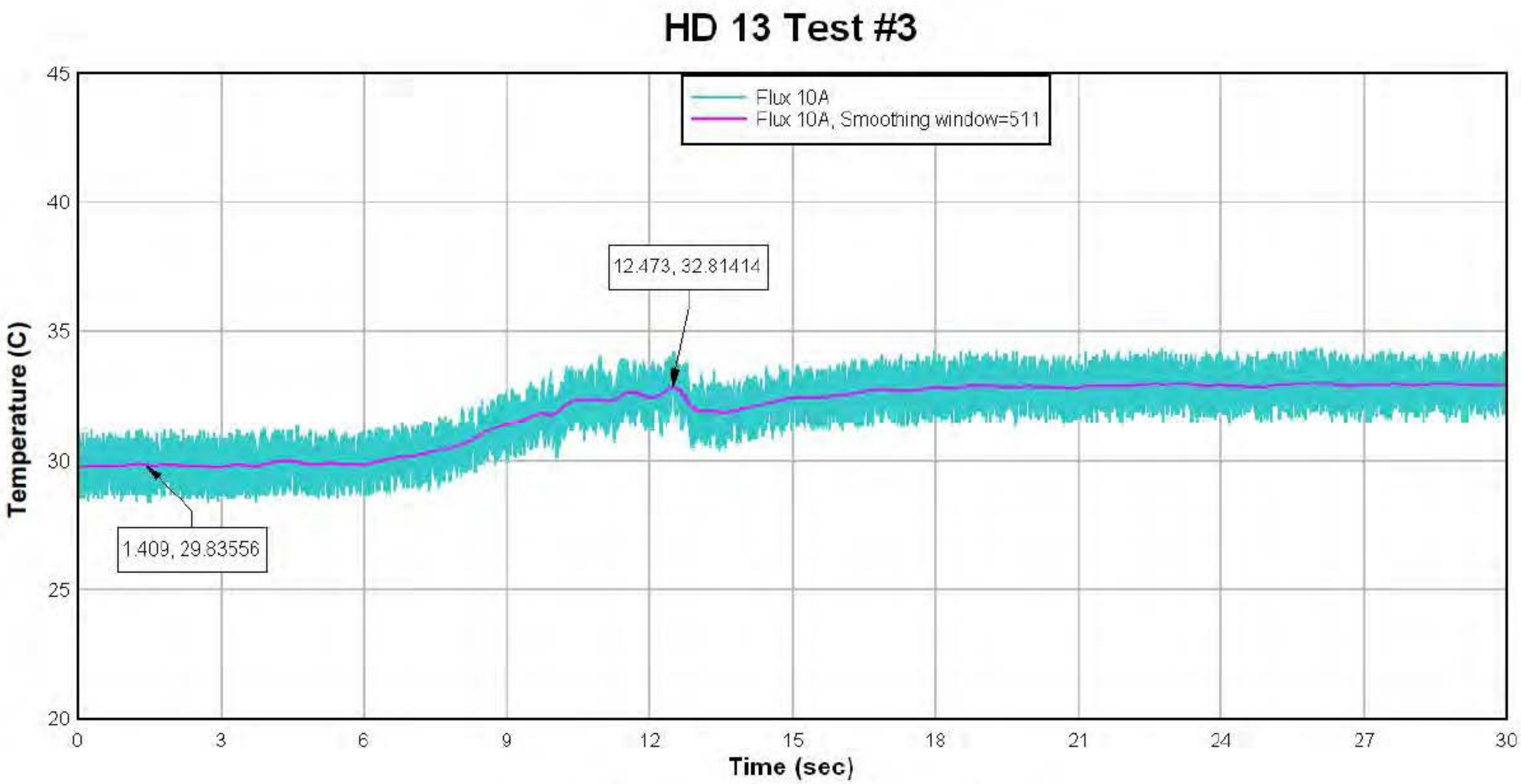

FIGURE IV-B-31. Flux Gage #10A (Outside).

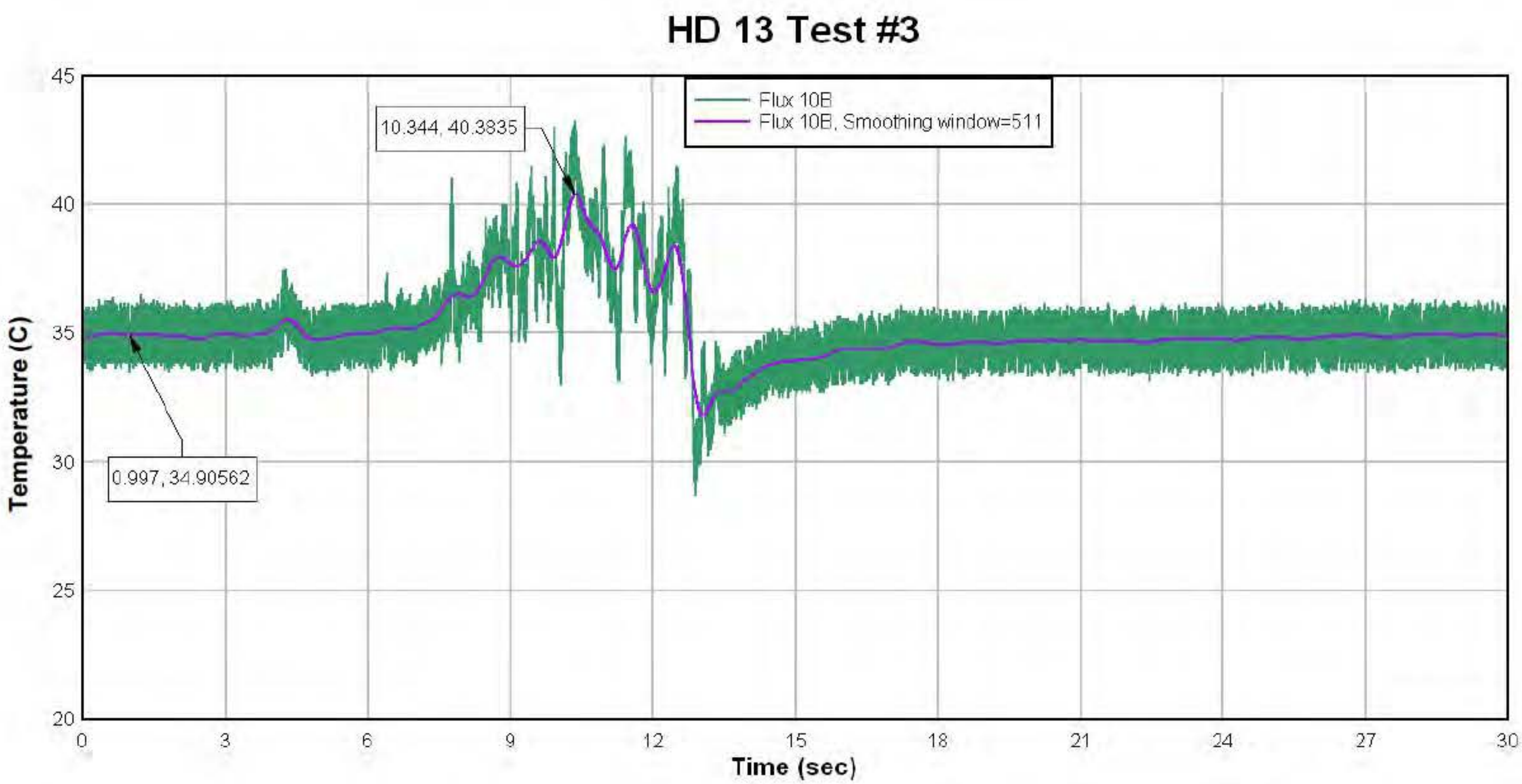

FIGURE IV-B-32. Flux Gage #10B (Outside).

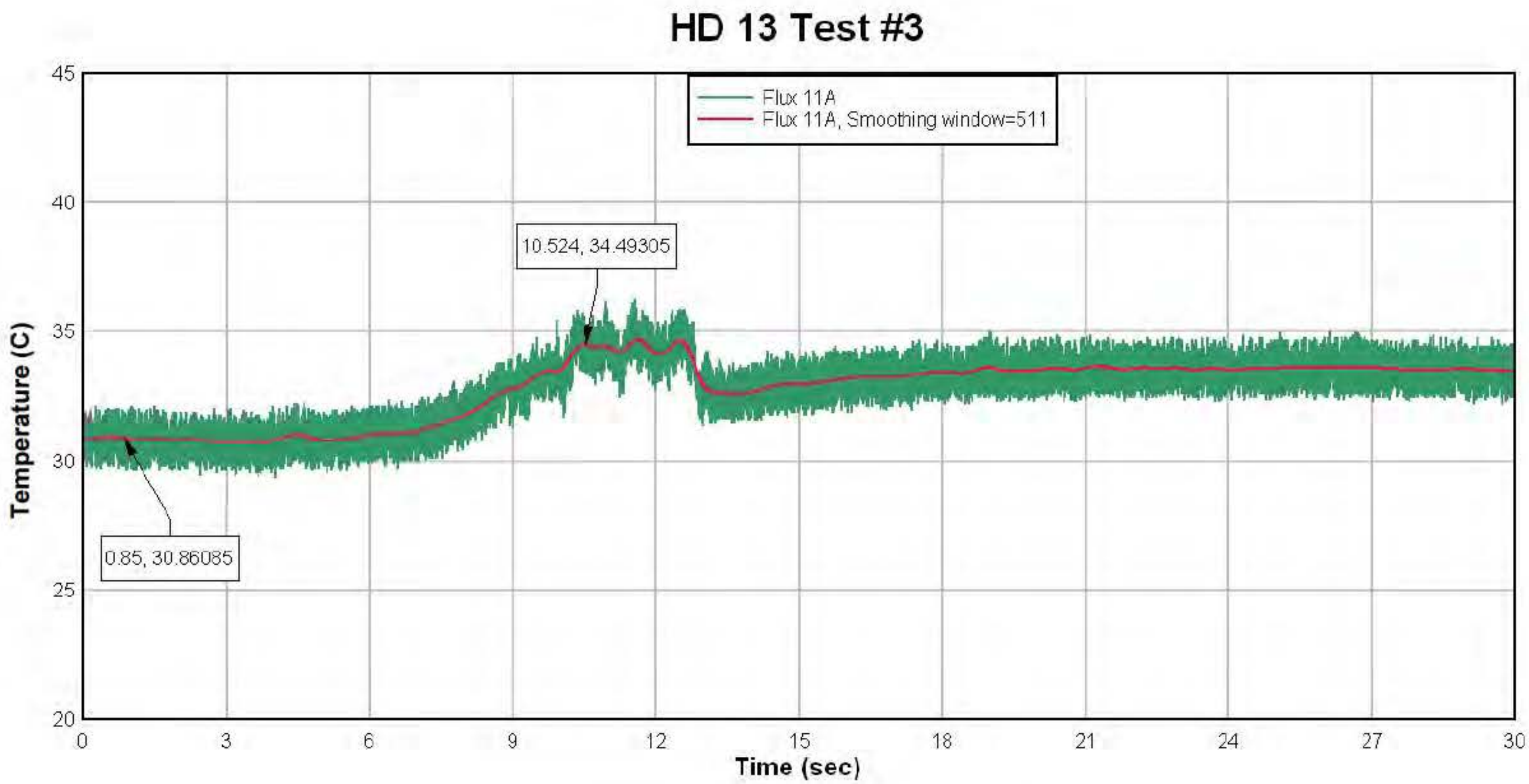

FIGURE IV-B-33. Flux Gage #11A (Outside).

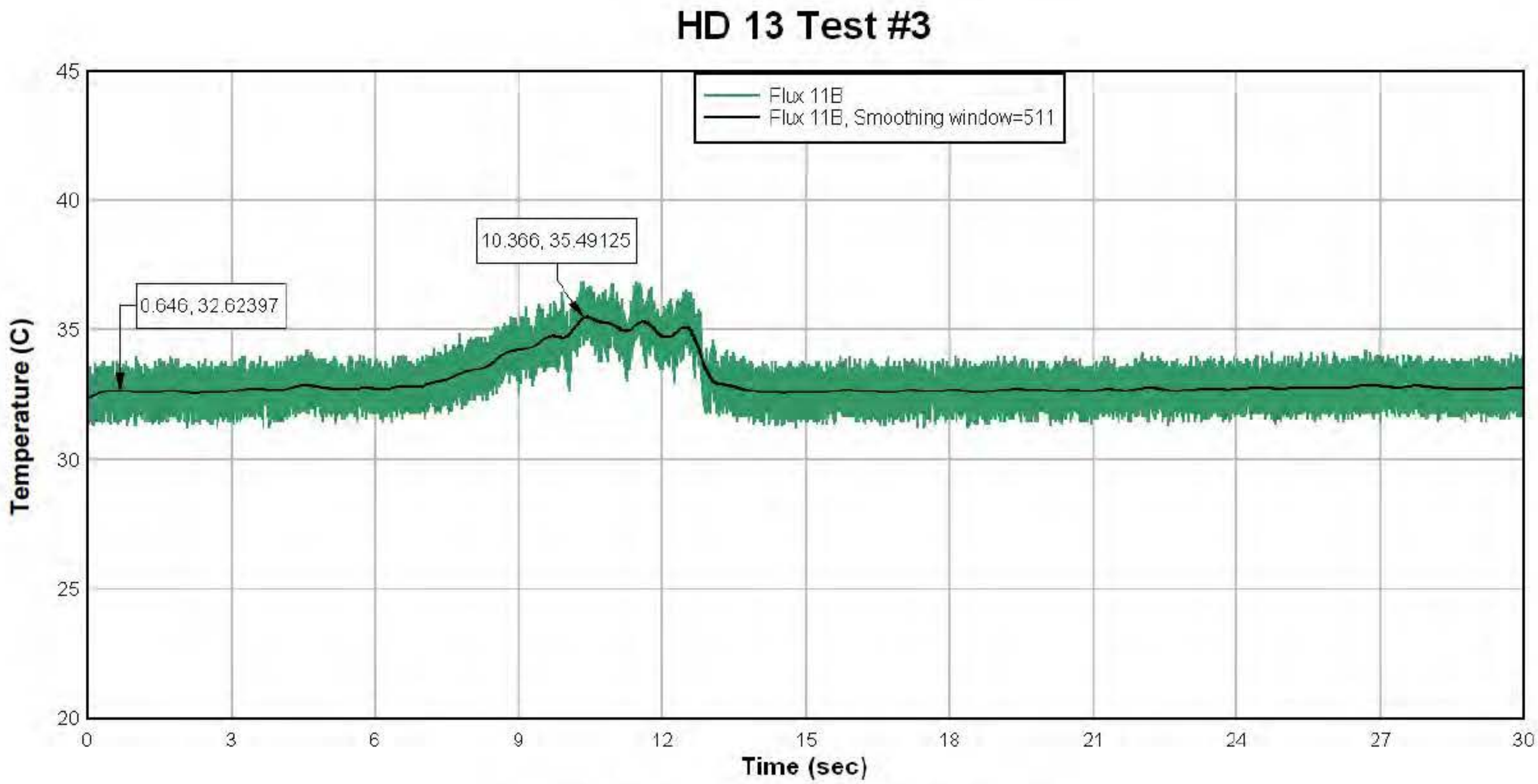

FIGURE IV-B-34. Flux Gage #11B (Outside).

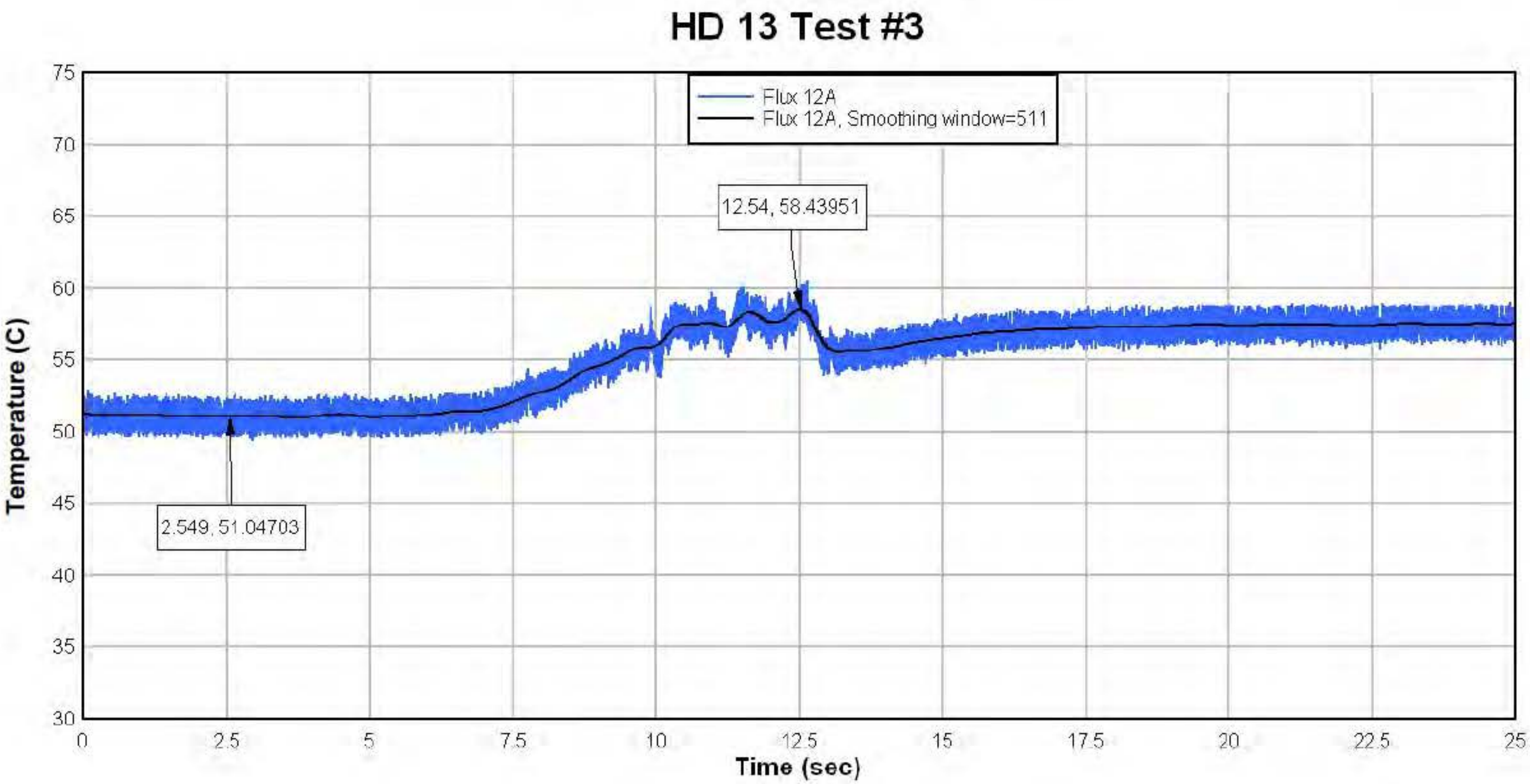

FIGURE IV-B-35. Flux Gage #12A (Outside).

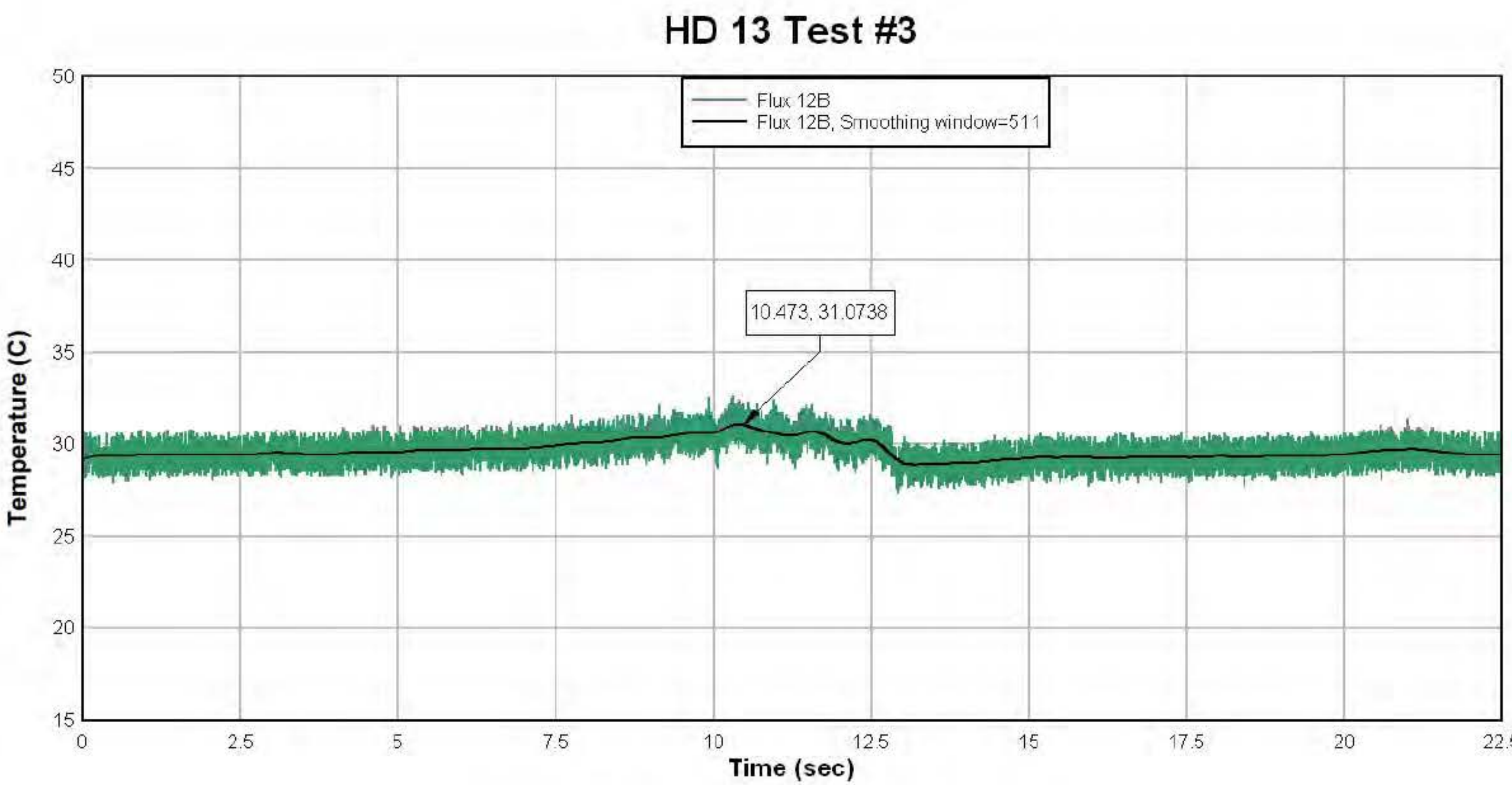

FIGURE IV-B-36. Flux Gage #12B (Outside).

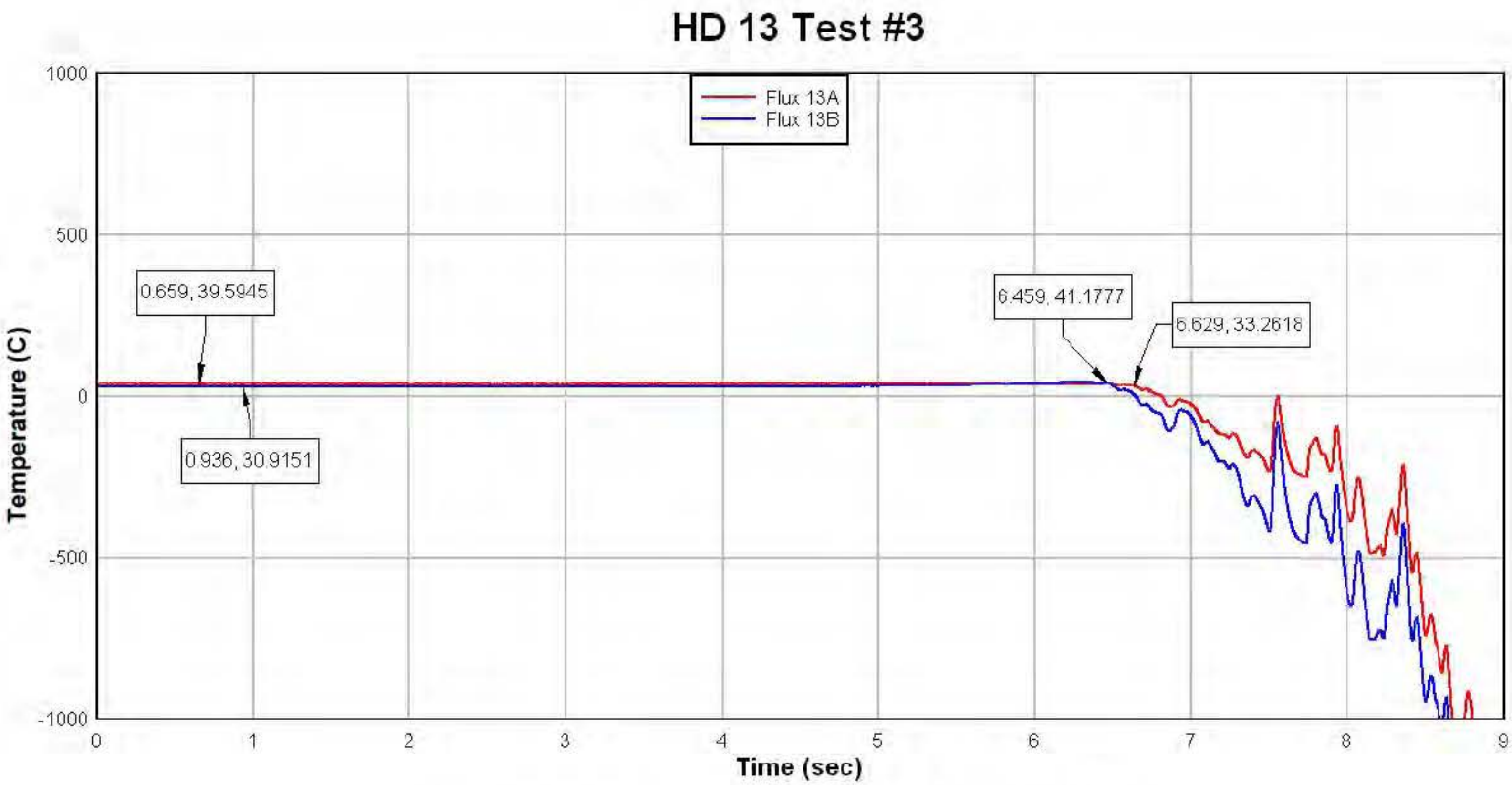

FIGURE IV-B-37. Flux Gage #13A and 13B (Outside).

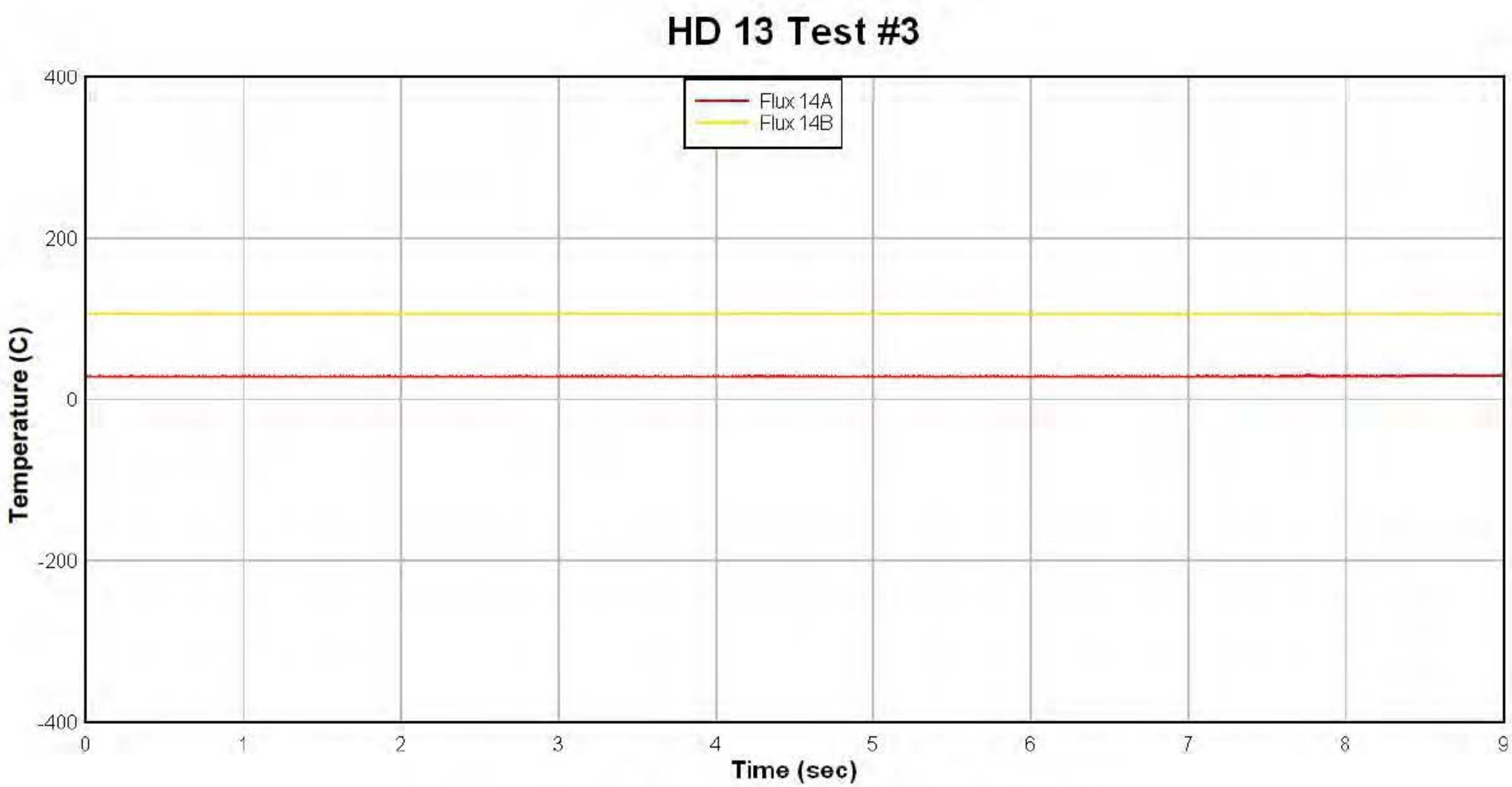

FIGURE IV-B-38. Flux Gage #14A and 14B (Outside).

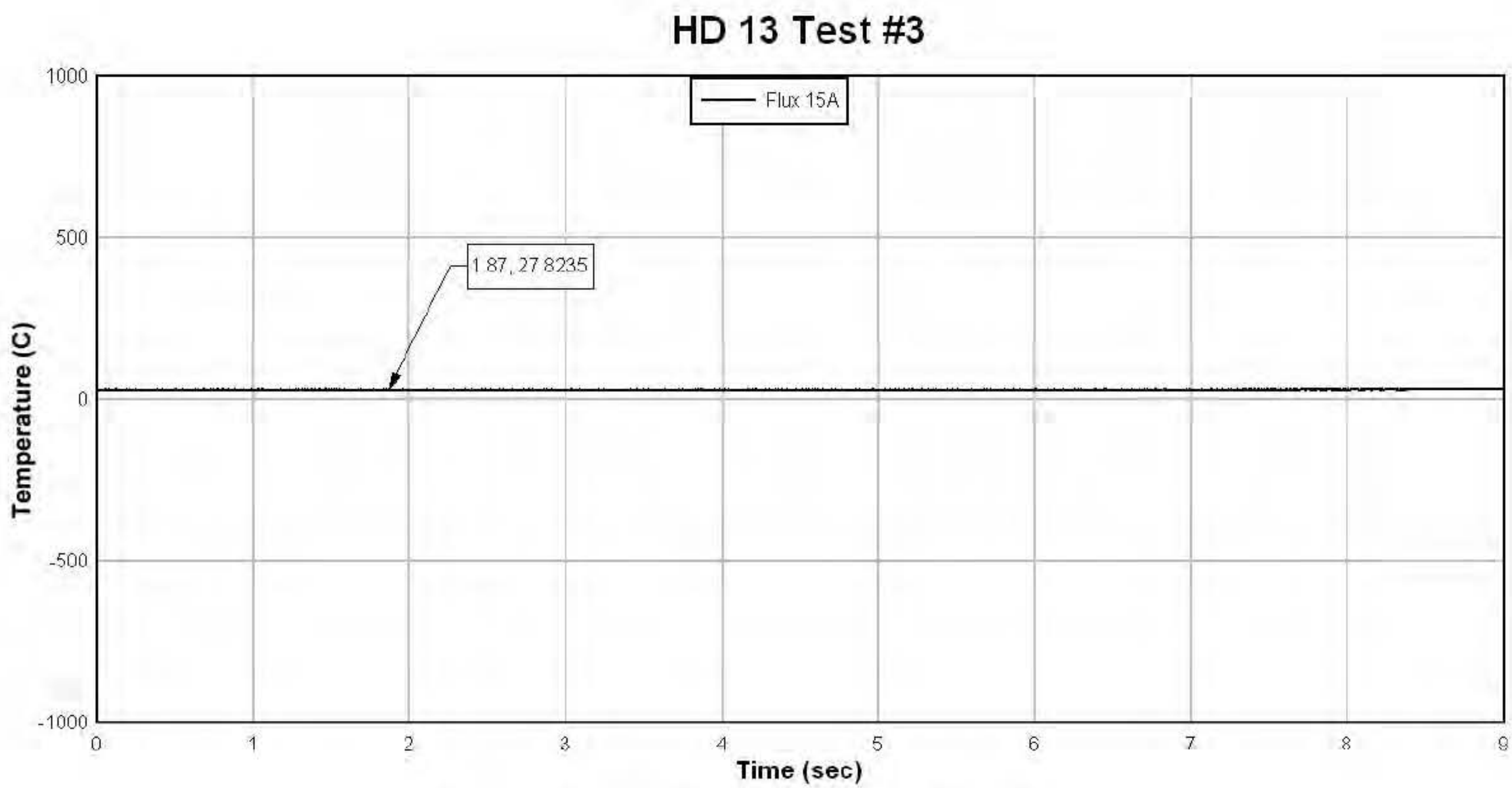

FIGURE IV-B-39. Flux Gage #15A (Outside).

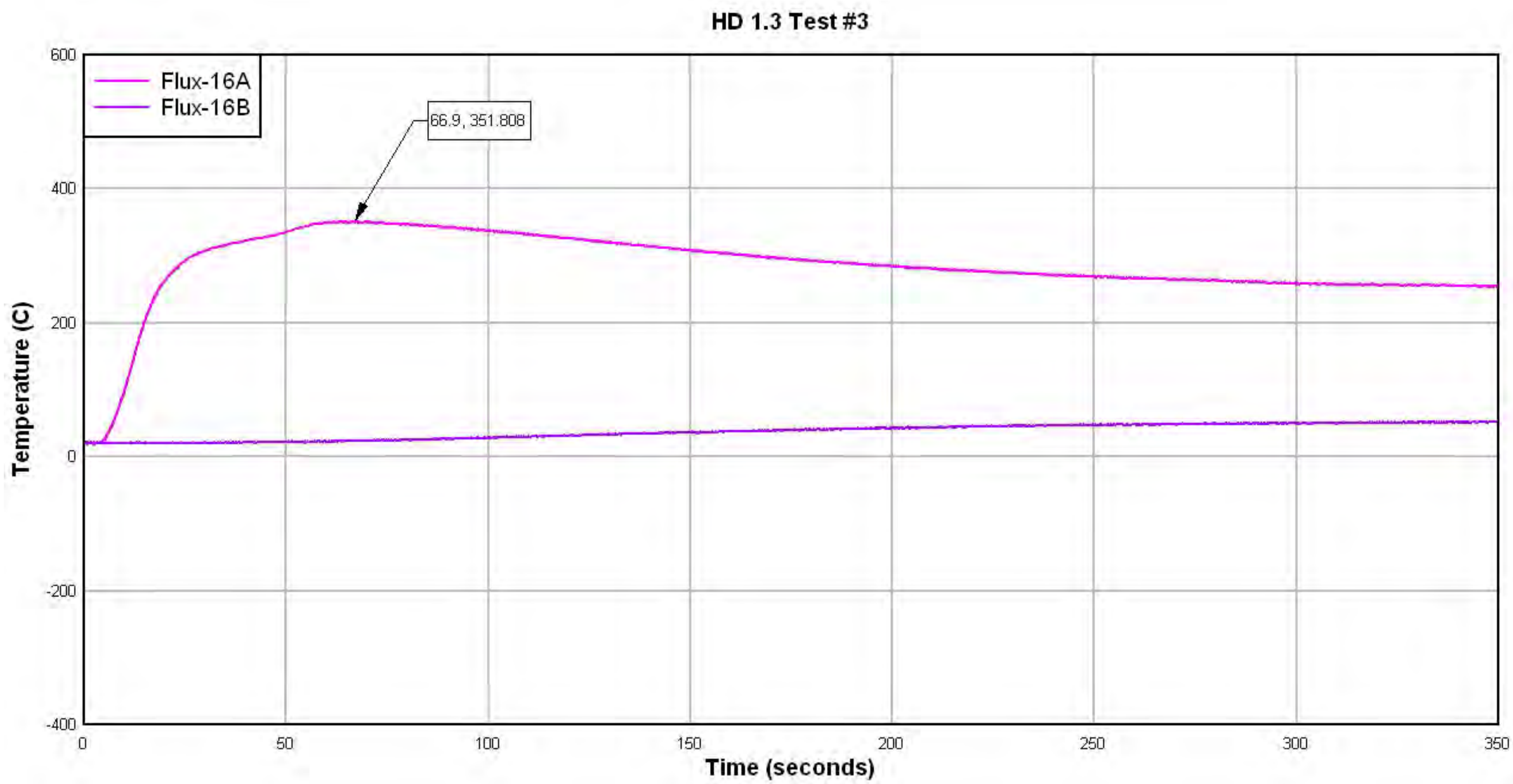

FIGURE IV-B-40. Flux Gage #16A and 16B (Inside).

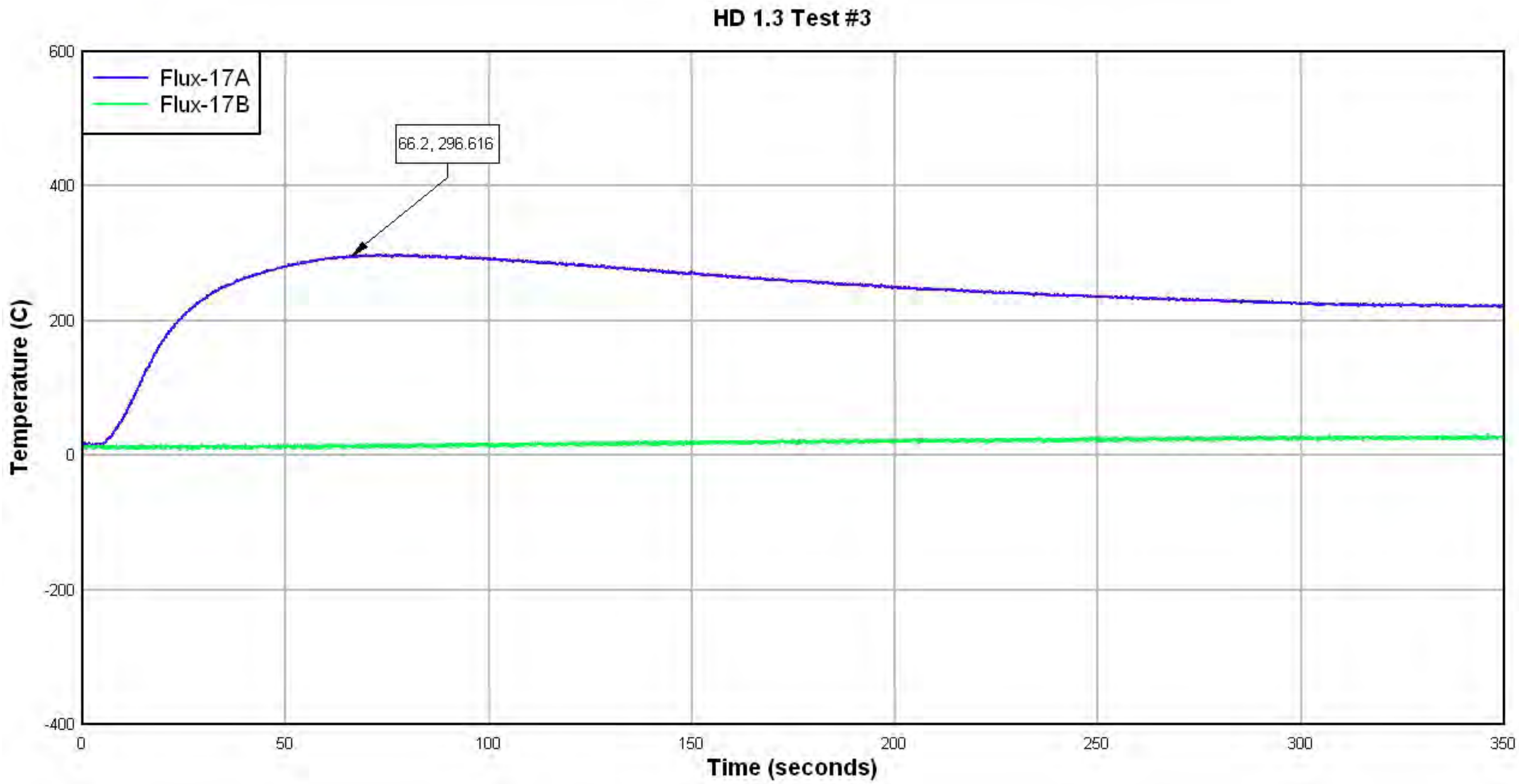

FIGURE IV-B-41. Flux Gage #17A and 17B (Inside).

Summary

- Peak Temperatures Inside Structure
  - Thermocouple # 17 – 1188.49C at 1.49 sec
  - 500 C at 55.04 sec Flux Gage 16A
- Peak Temperatures Outside Structure
  - 164.66C at 1.5 sec Flux Gage 5A

THERMAL FLUX DATA INTERNAL AND EXTERNAL TO THE STRUCTURE

Explanation of the Sensitivity study

- Based on the recording speed of the DAQ system the data was delaminated with an average of points that fit the sample rate of the gages
  - Providing a data point per second or 4 pts per second
  - Difference in the magnitude and location of the plots was minimal.
  - Decided to use cleanest plot for each DFT measurement

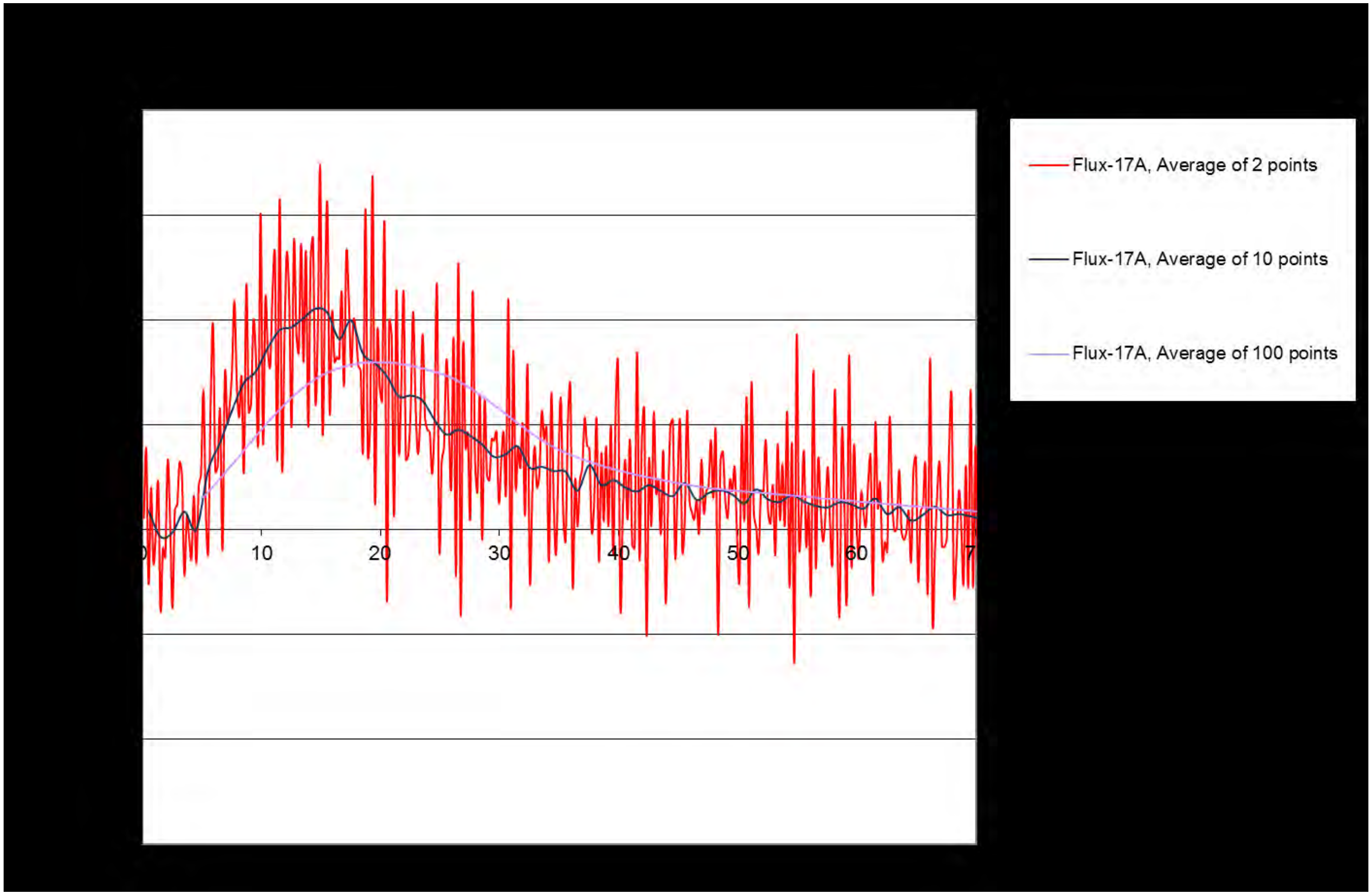

FIGURE IV-B-42. Example: Sensitivity Study.

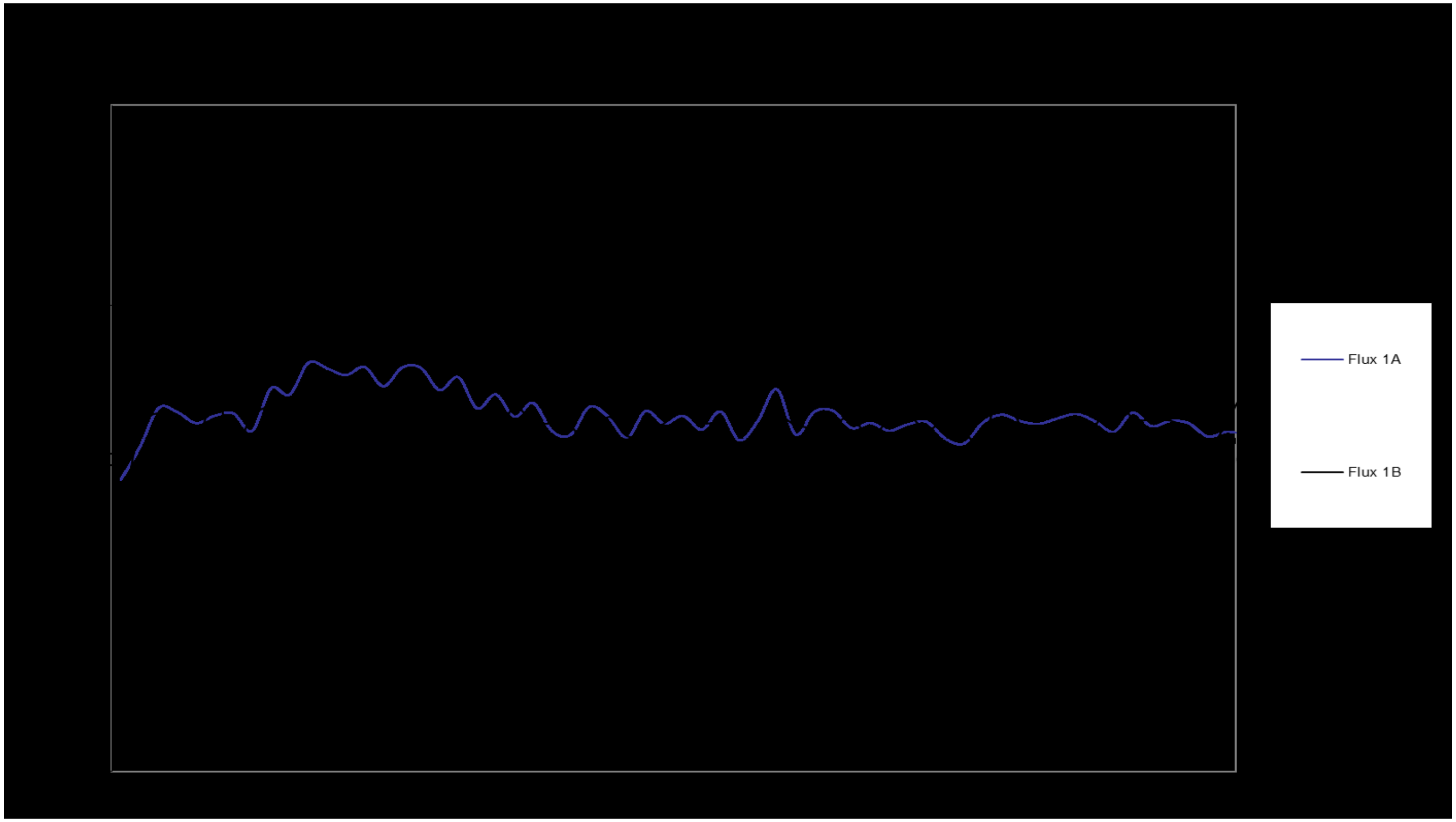

FIGURE IV-B-43. Heat Flux Gages #1A.

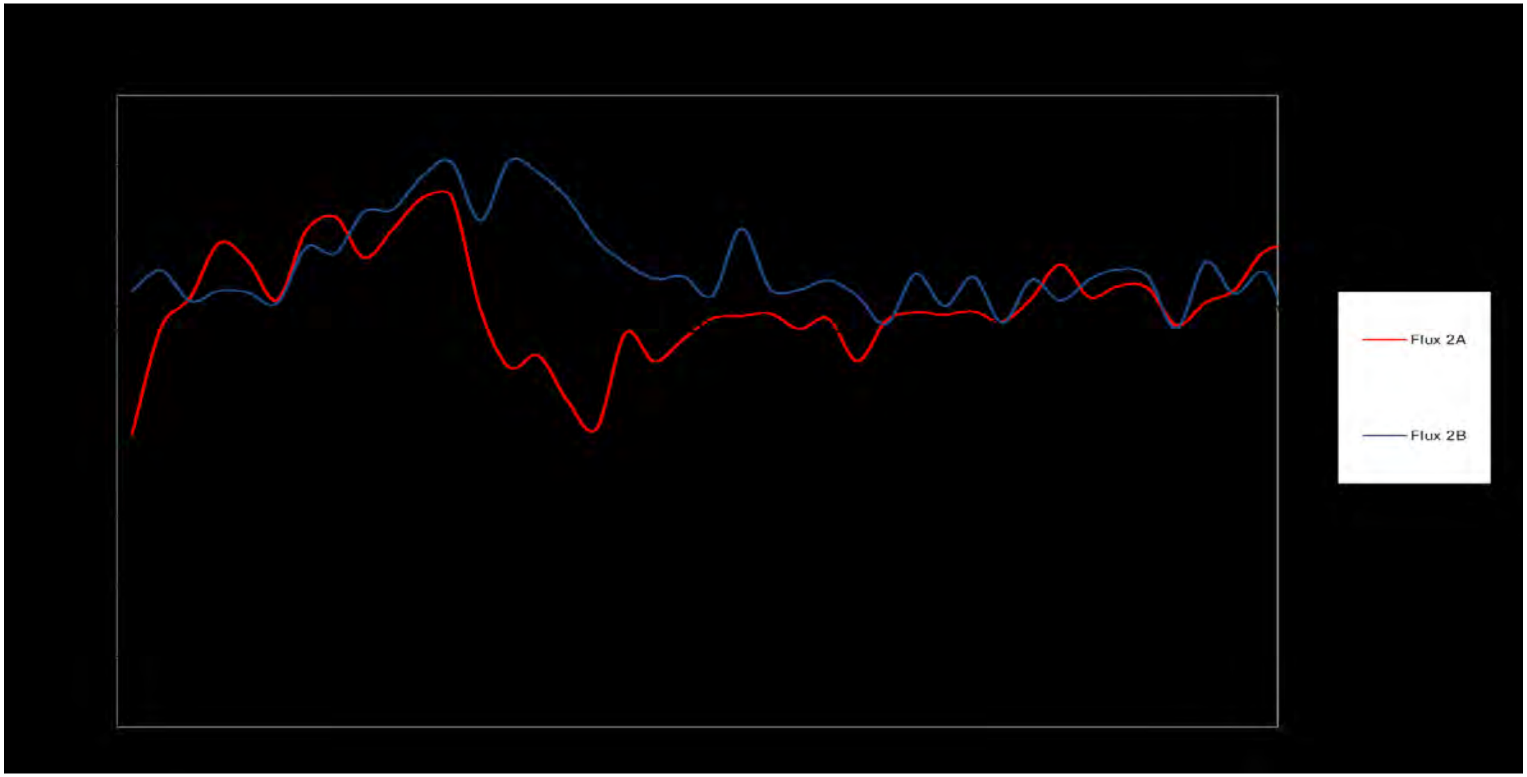

FIGURE IV-B-44. Heat Flux Gages #2A and 2B.

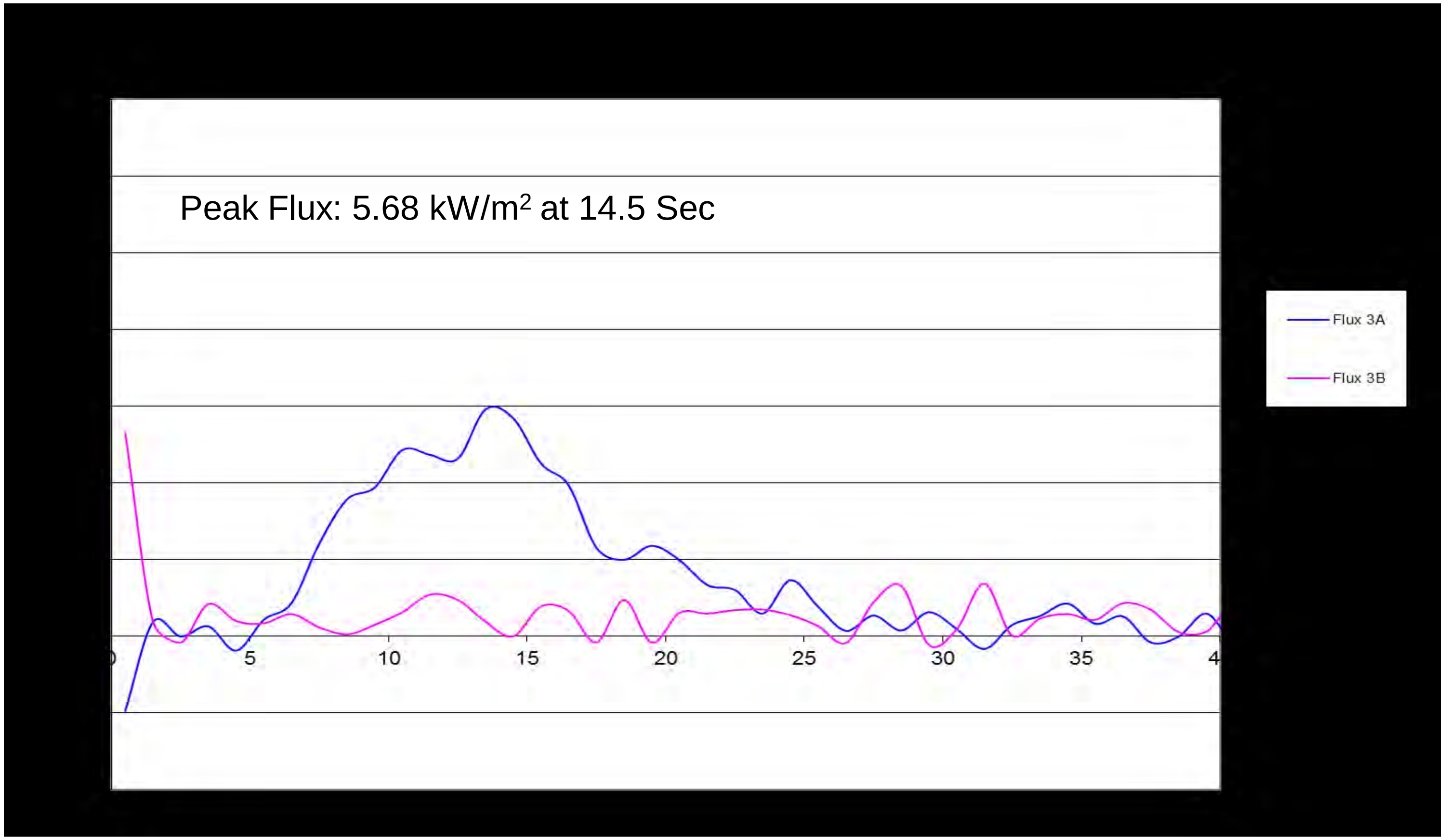

FIGURE IV-B-45. Heat Flux Gages #3A and 3B.

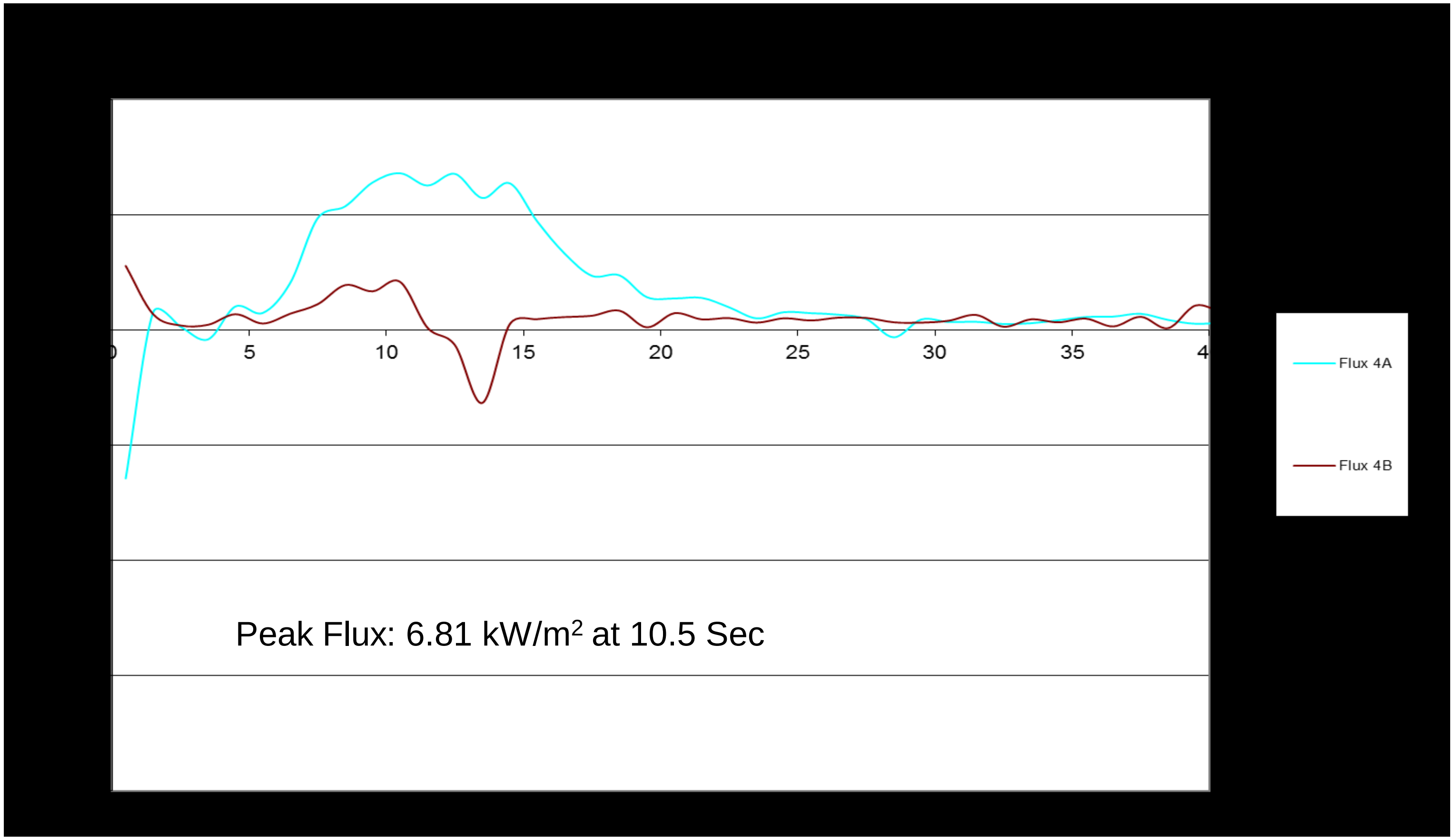

FIGURE IV-B-46. Heat Flux Gages #4A and 4B.

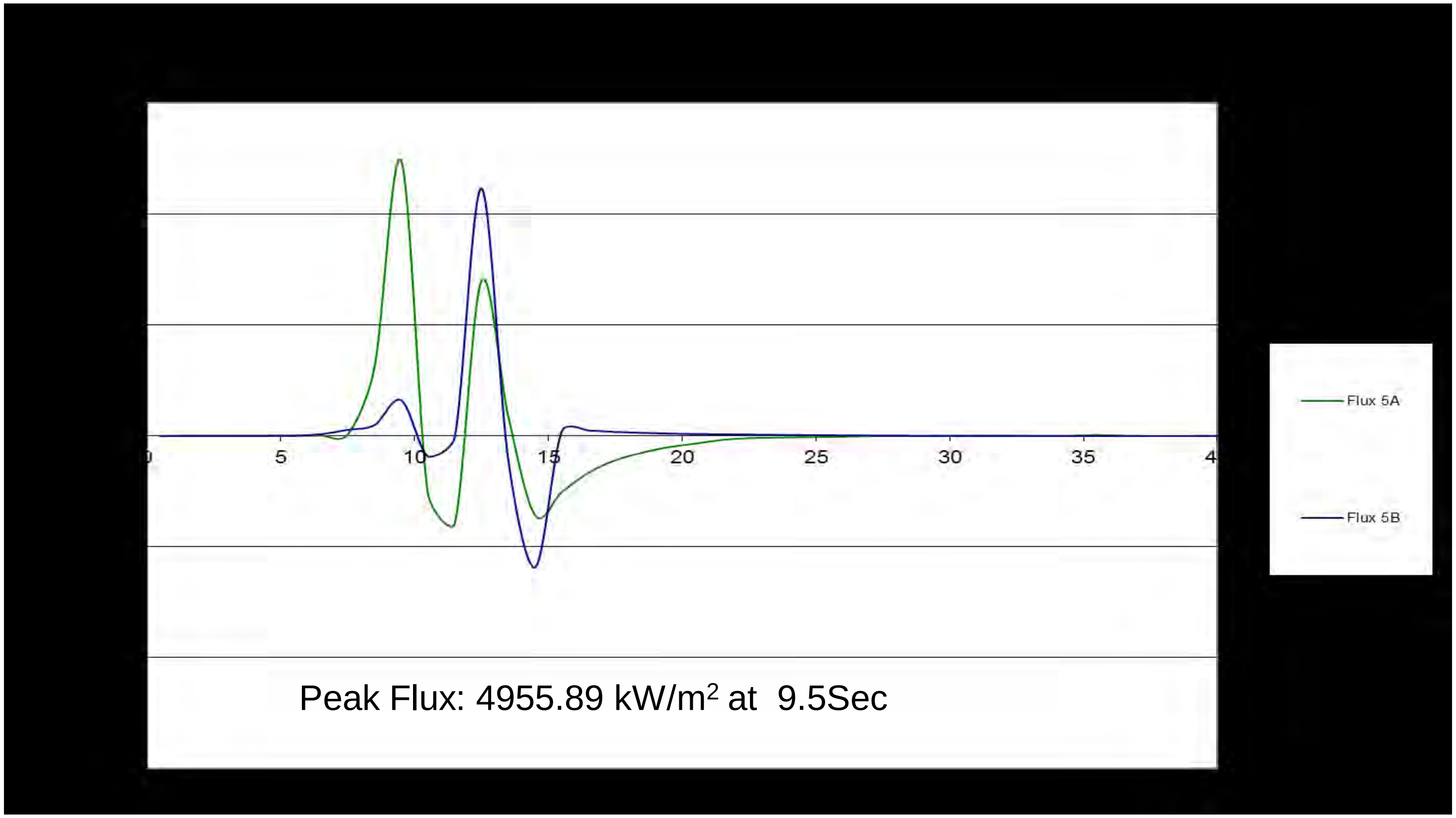

FIGURE IV-B-47. Heat Flux Gages #5A and 5B.

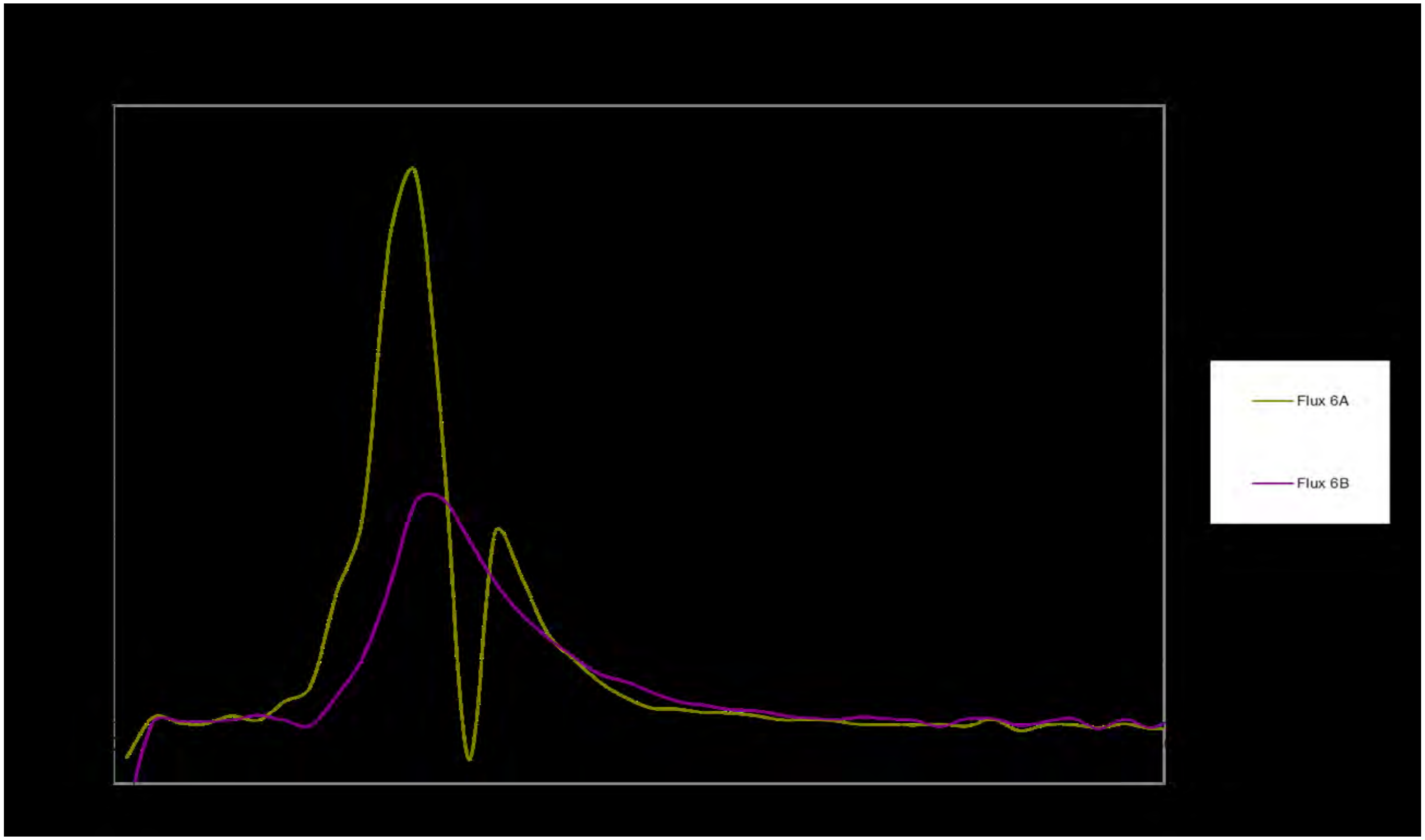

FIGURE IV-B-48. Heat Flux Gages #6A and 6B.

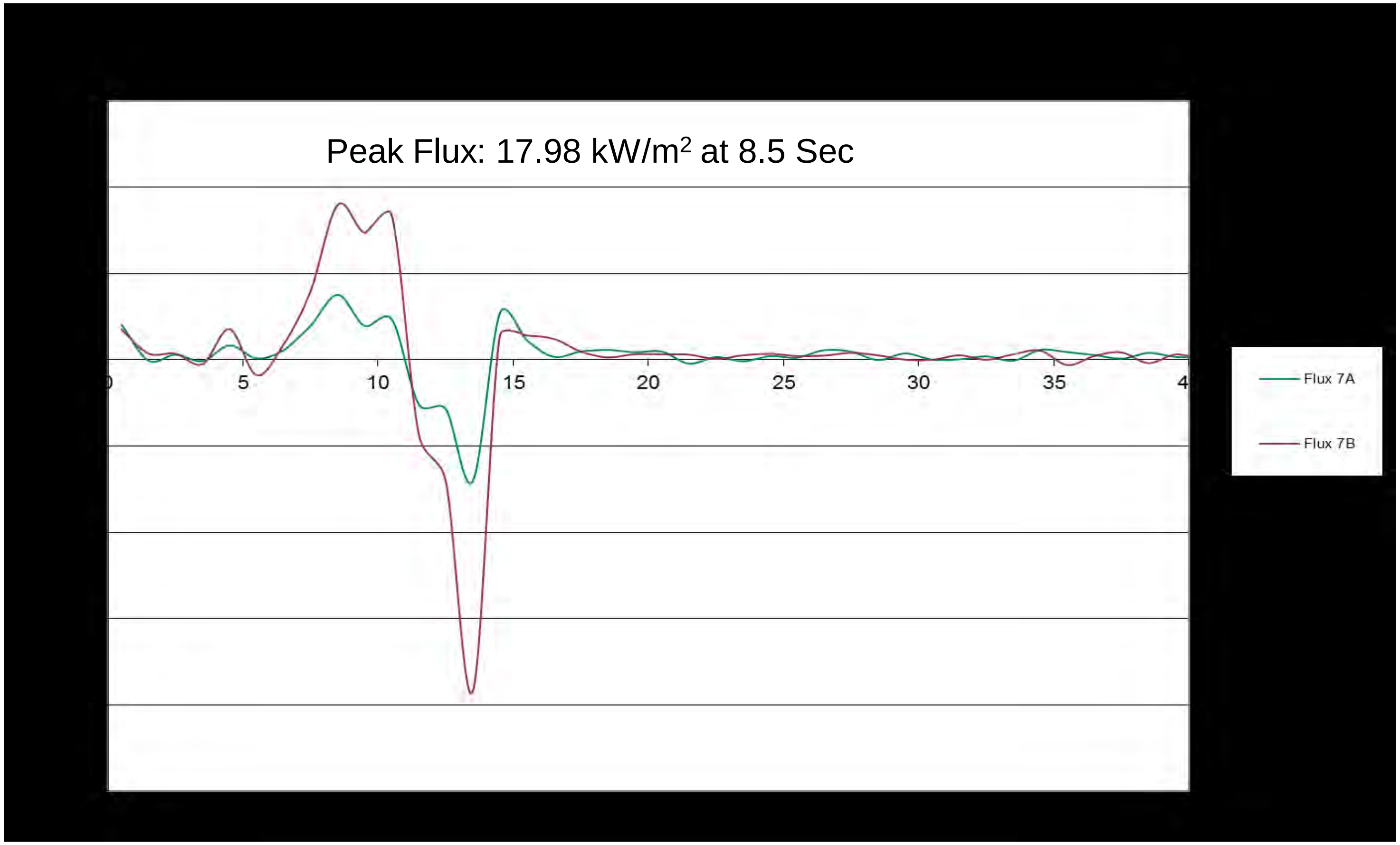

FIGURE IV-B-49. Heat Flux Gages #7A and 7B.

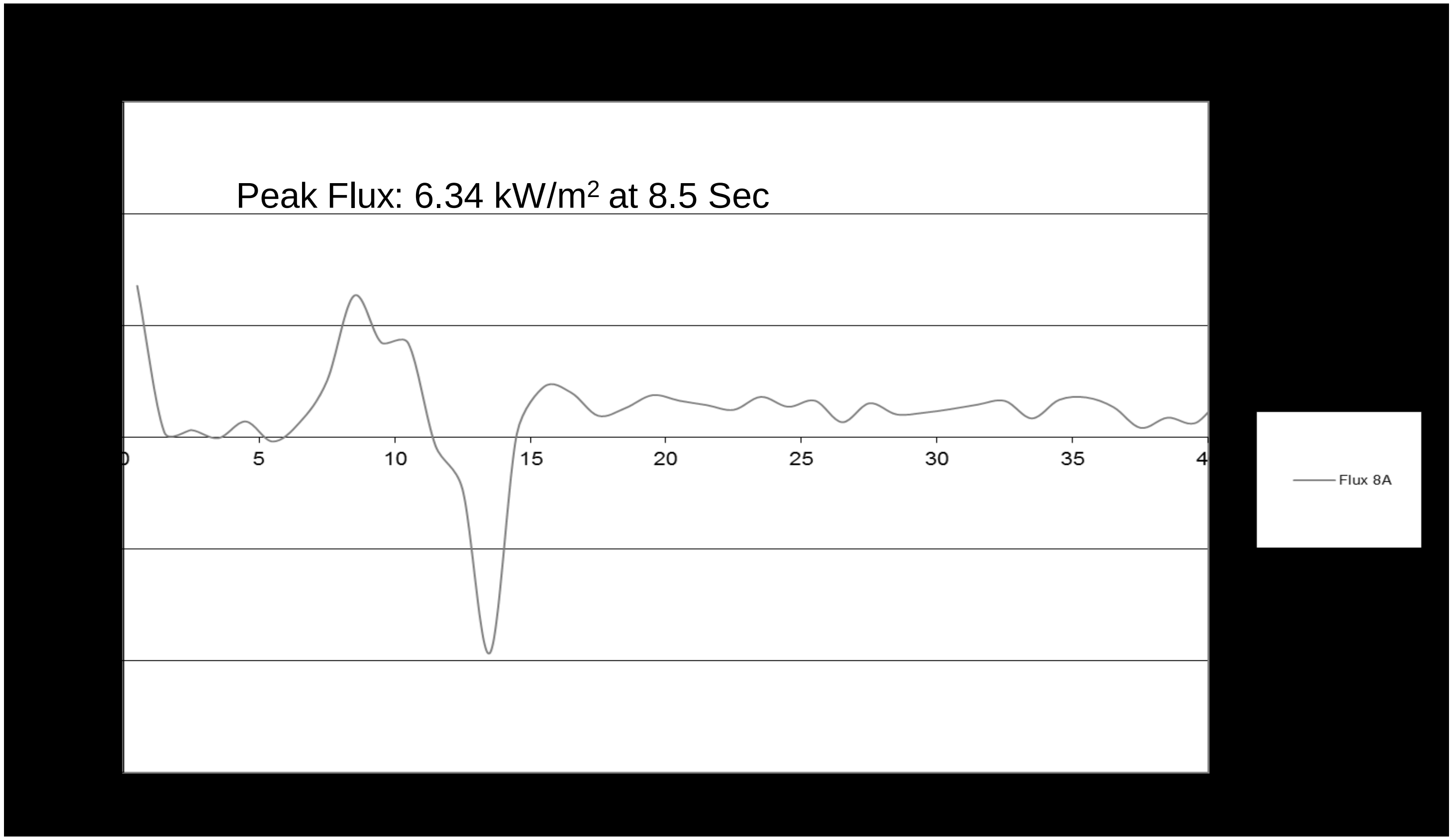

FIGURE IV-B-50. Heat Flux Gages #8A, Front Face.

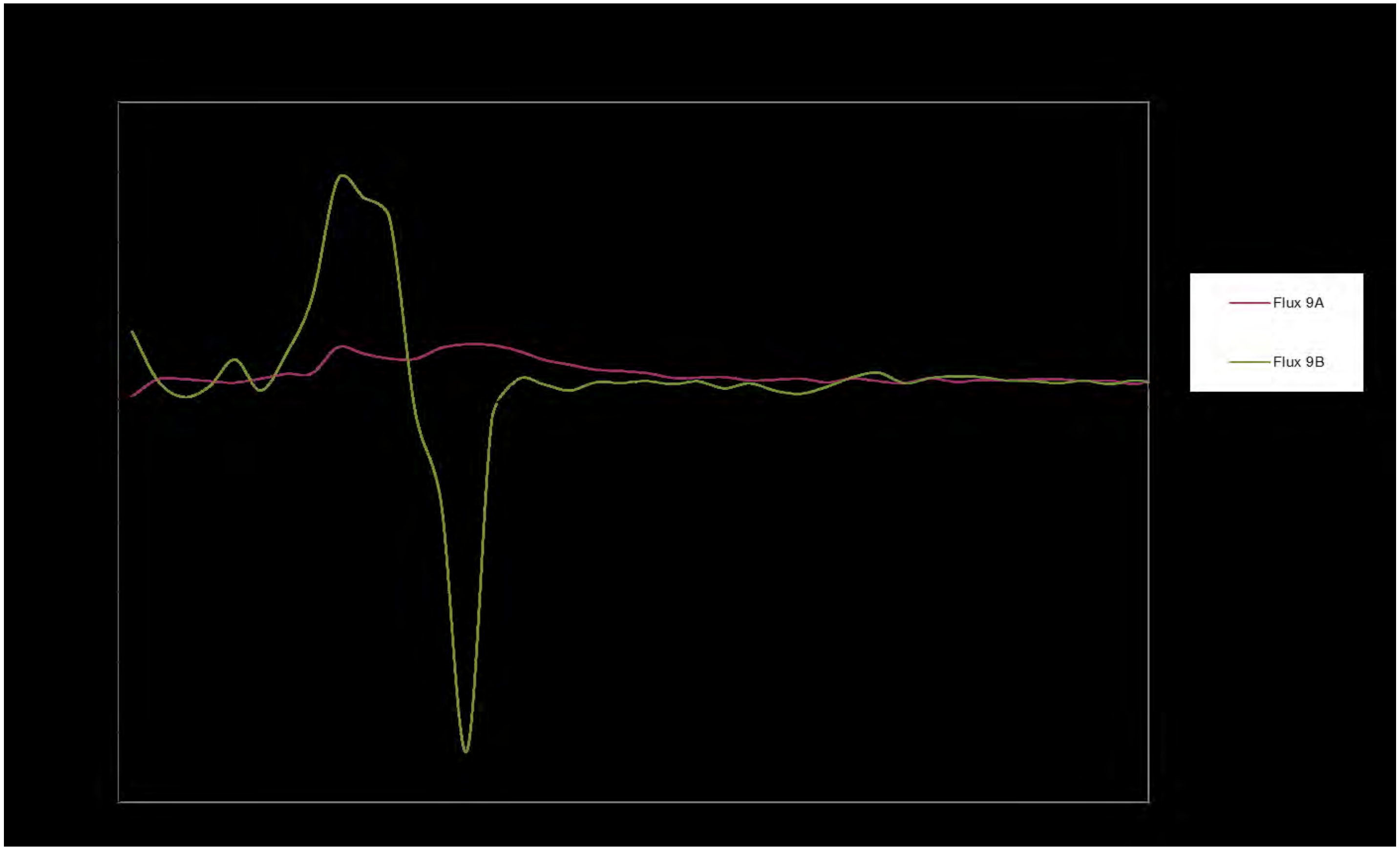

FIGURE IV-B-51. Heat Flux Gages #9A and 9B.

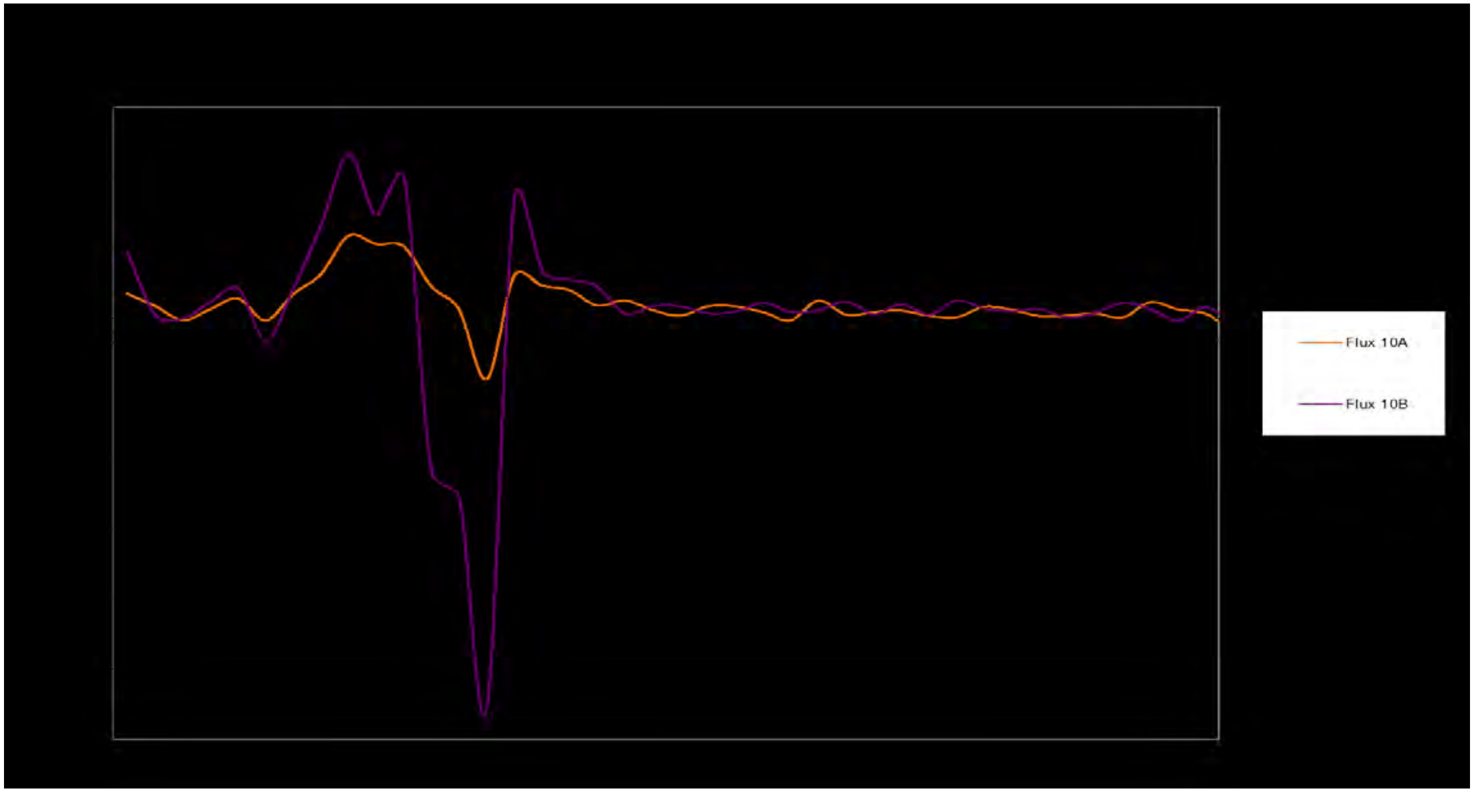

FIGURE IV-B-52. Heat Flux Gages #10A and 10B.

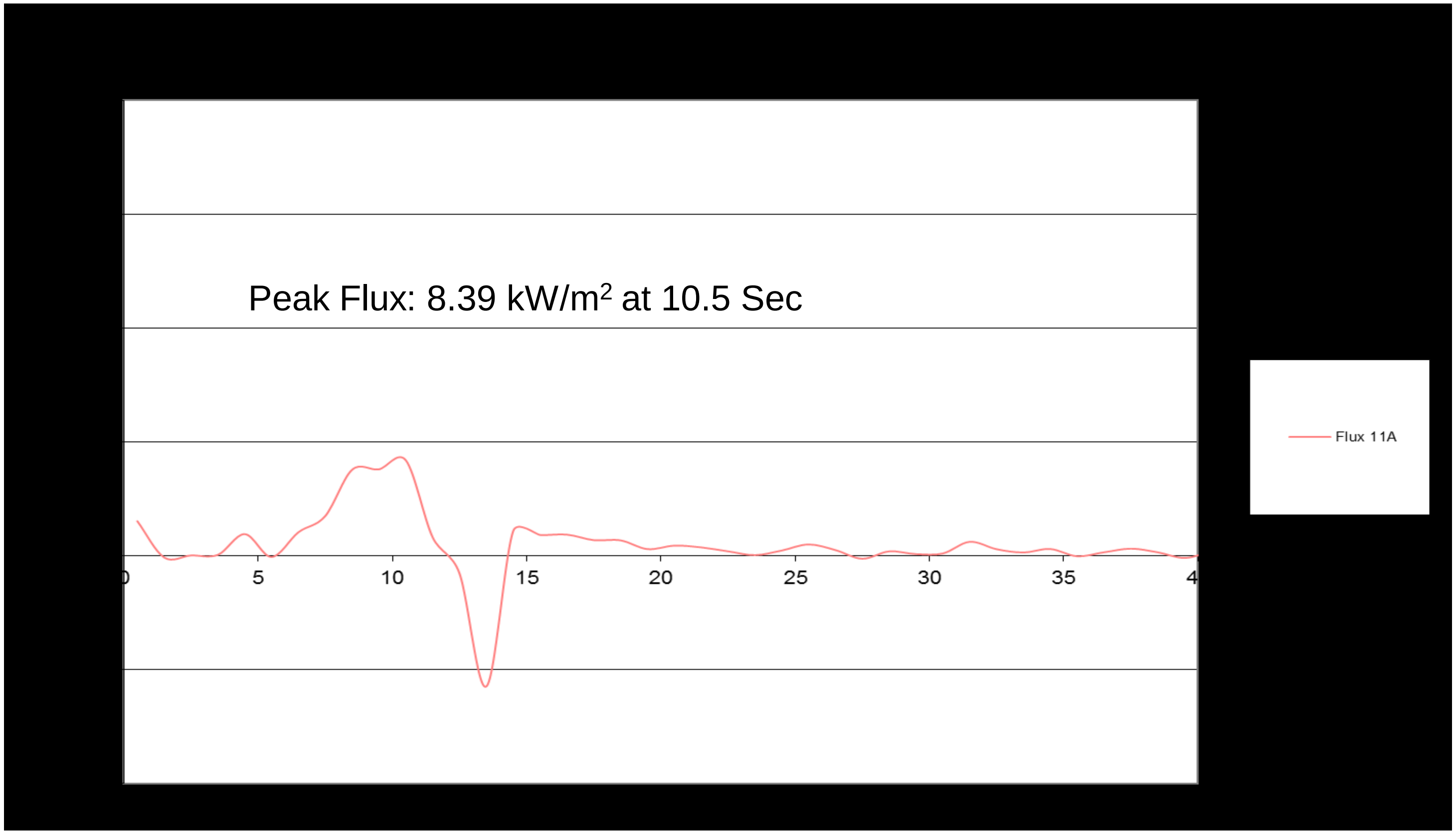

FIGURE IV-B-53. Heat Flux Gages #11A, Front Face.

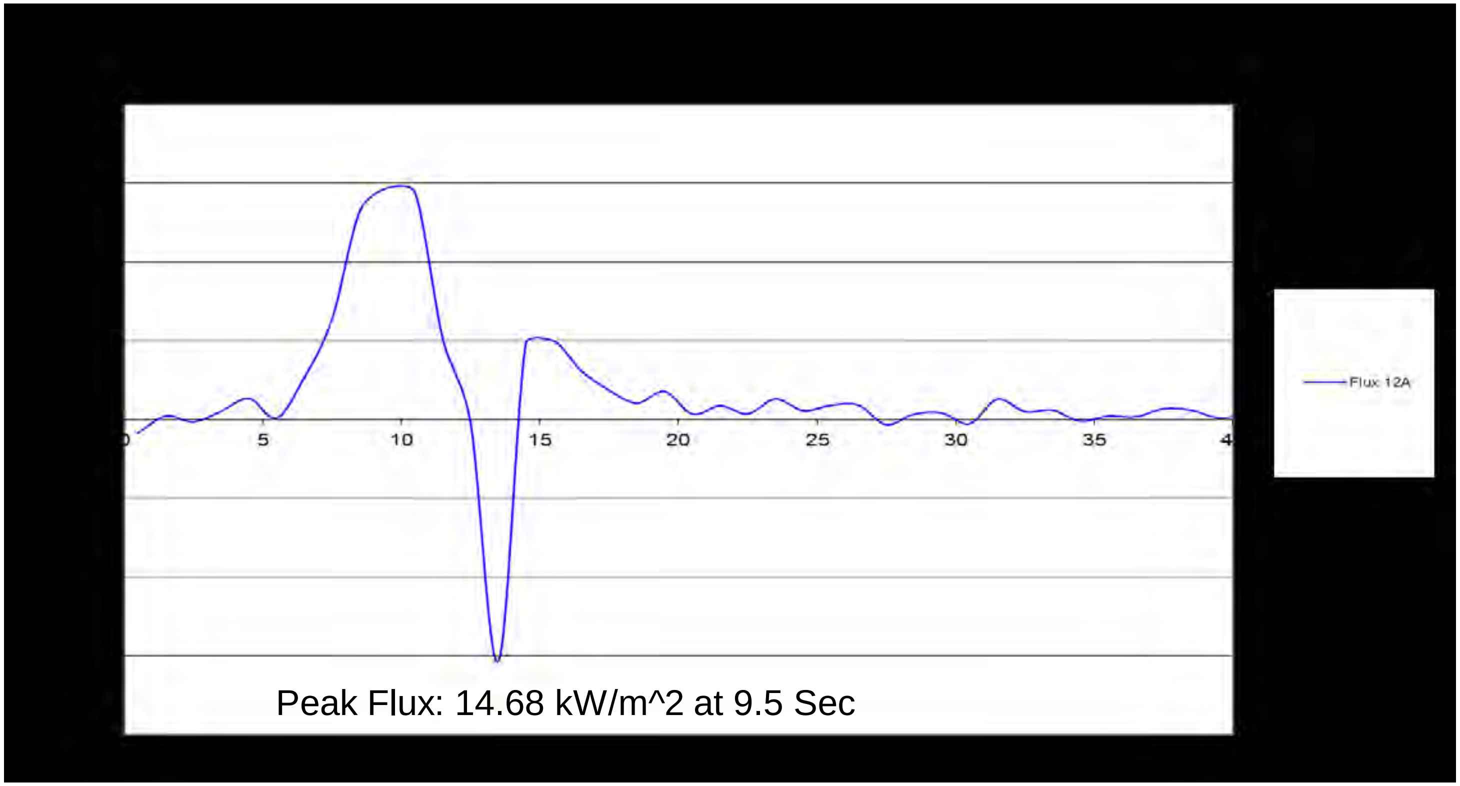

FIGURE IV-B-54. Heat Flux Gages #12A, Front Face.

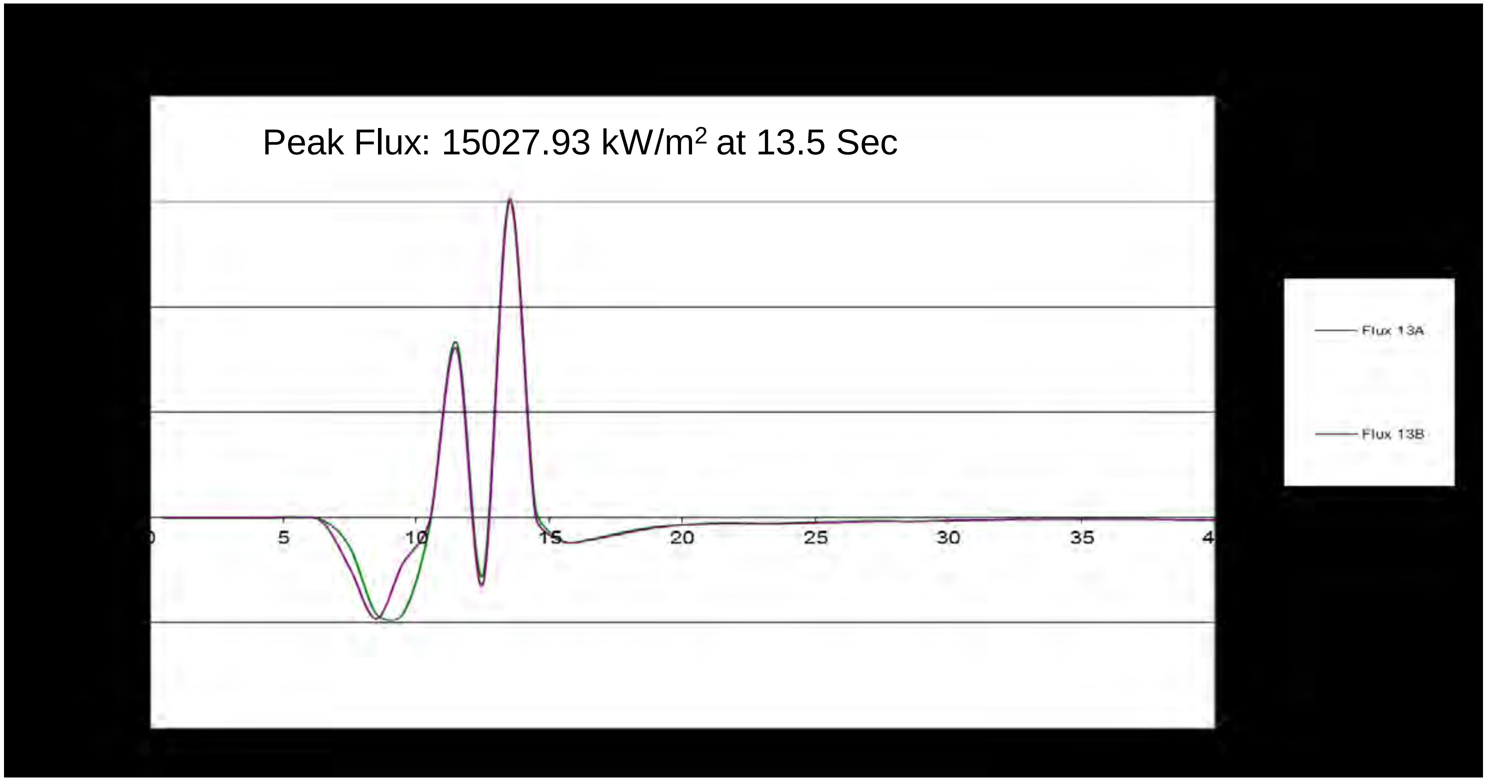

FIGURE IV-B-55. Heat Flux Gages #13A and 13B.

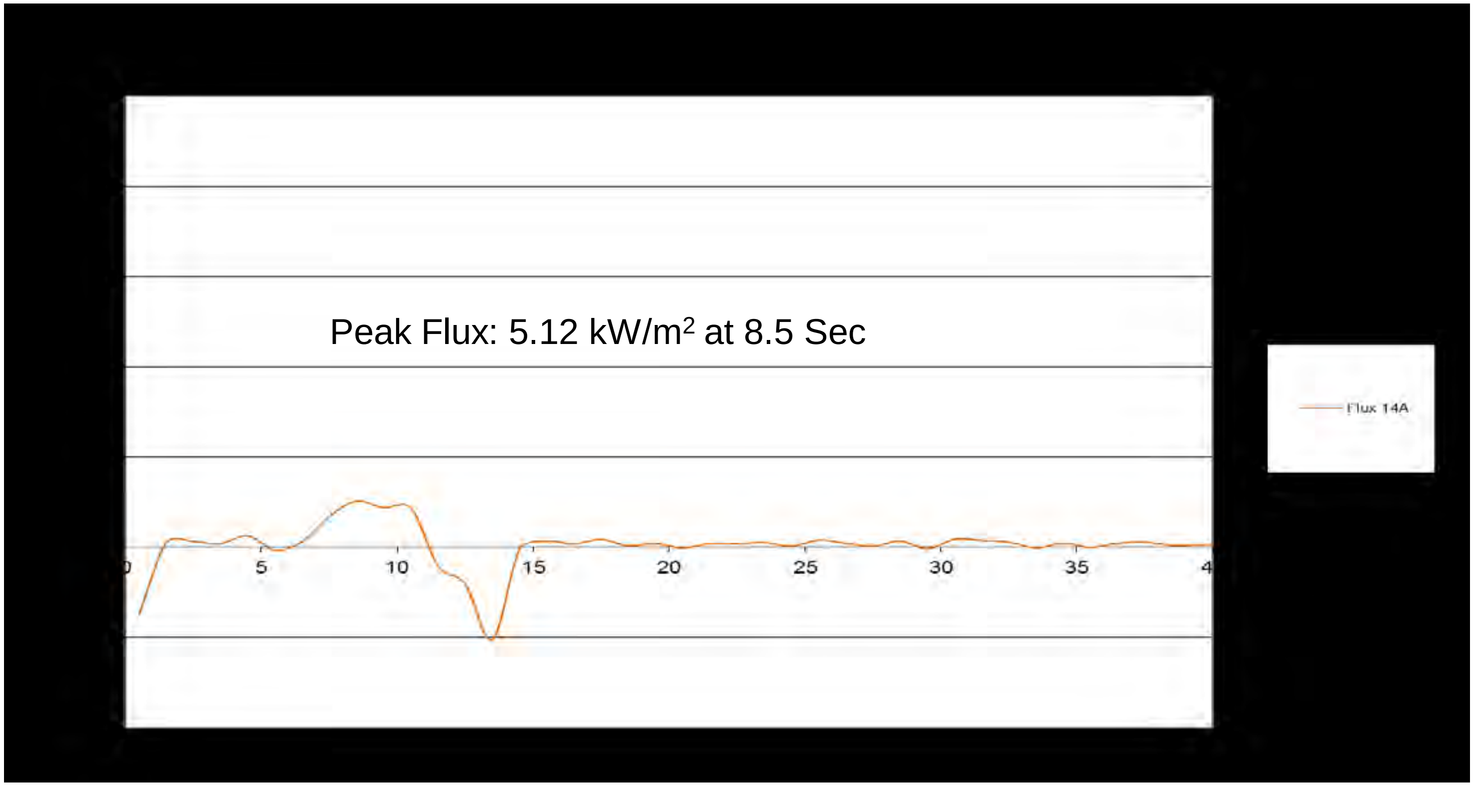

FIGURE IV-B-56. Heat Flux Gages #14A.

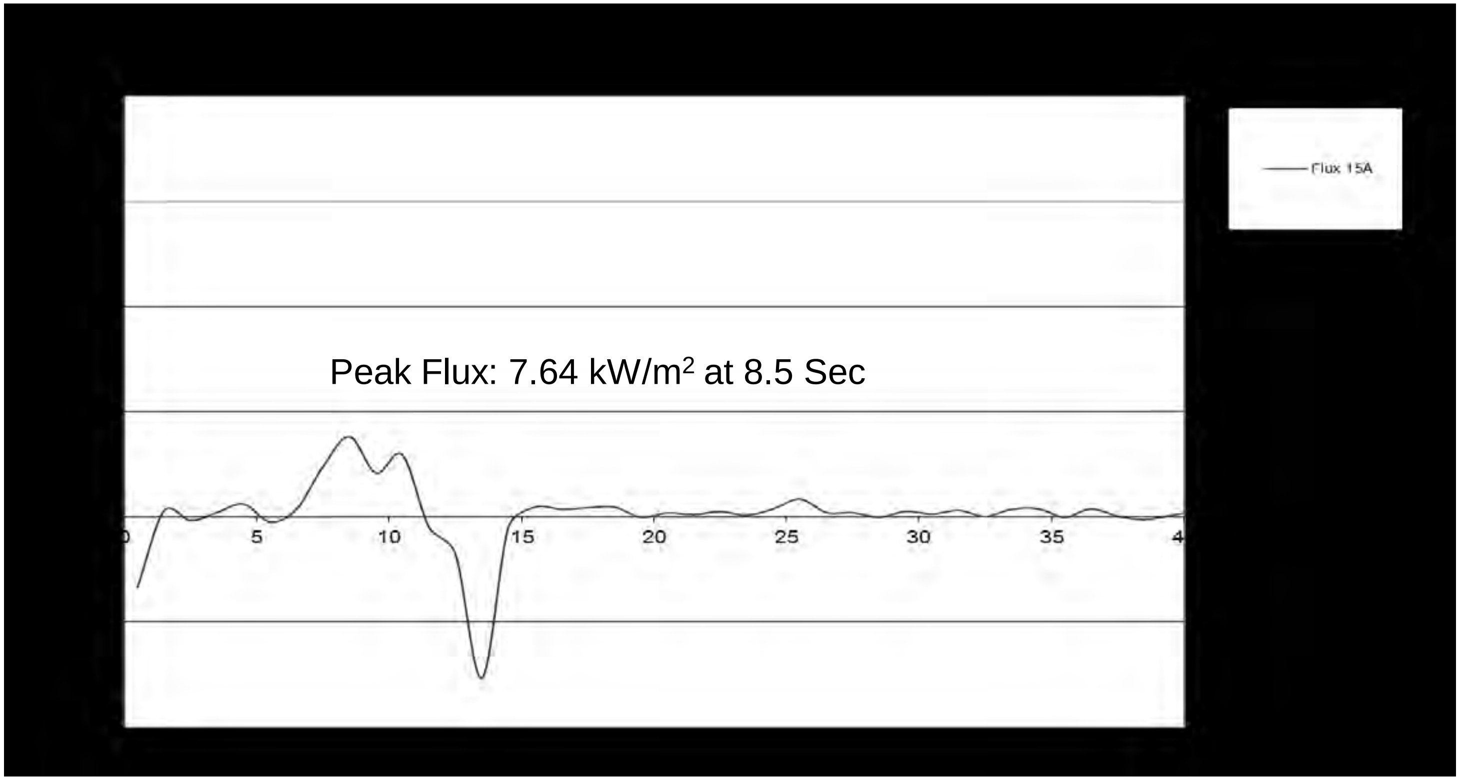

FIGURE IV-B-57. Heat Flux Gages #15A, Front Face.

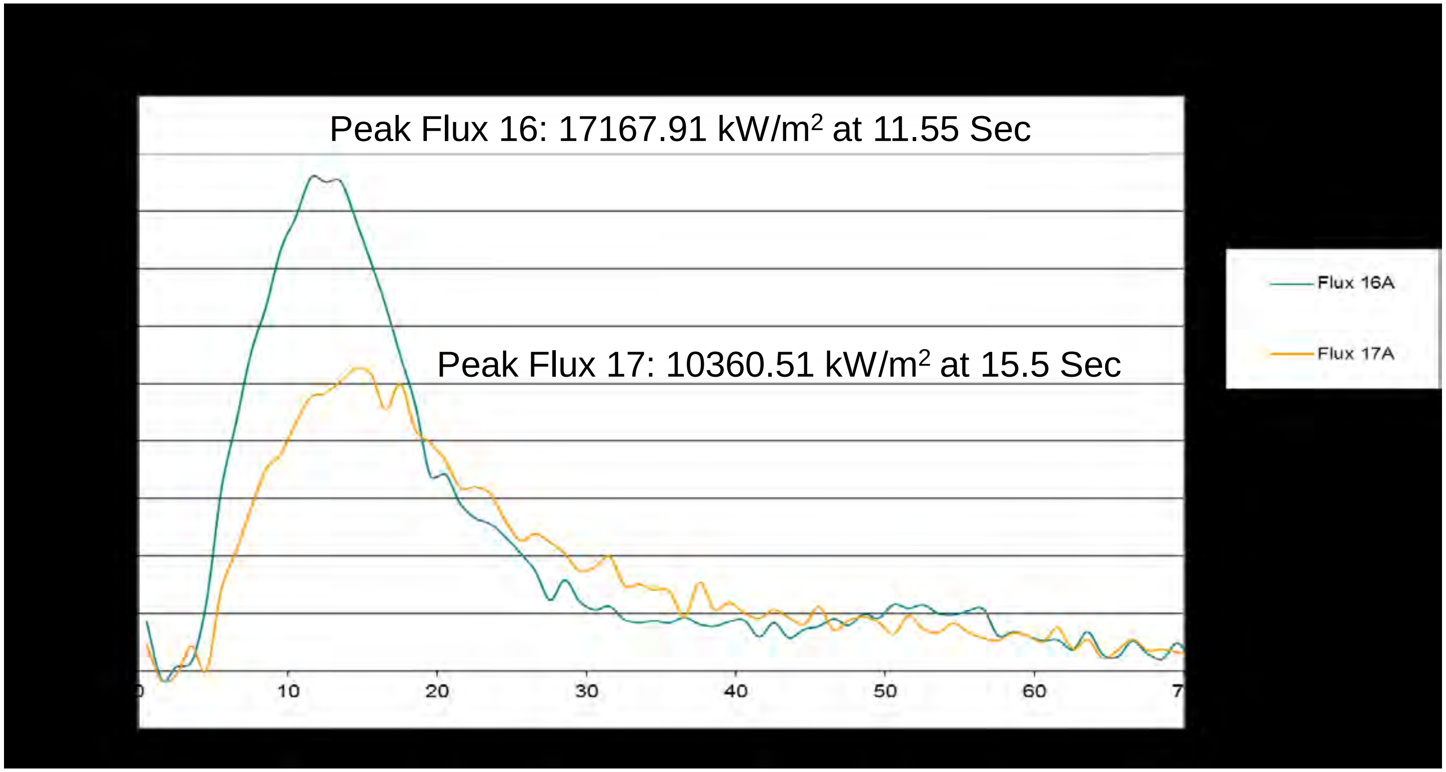

FIGURE IV-B-58. Internal Flux Gages #16A and 17A.

Summary

- Peak Flux Inside Structure
  - – DFT #16 – 17167.91 kW/m^2 at 11.55 sec
  - – DFT #17 – 10360.51 kW/m^2 at 15.5 sec
- Peak Flux Outside Structure
  - – DFT #13 – 15027.93 kW/m^2 at 13.5 sec (15ft 5in)
  - – DFT #5 – 38461.96 kW/m^2 at 8.88 sec (31ft 5in)
  - – DFT #6 – 89.19 kW/m^2 at 11.5sec (62ft, 4in)
  - – DFT# 9 – 29.07 kW/m^2 at 8.5 sec (31ft 5 in , 53ft east of centerline)

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Appendix IV-C

HD1.3 TEST 3. INFRARED IMAGES

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FIGURE IV-C-1. Black and White IR Image #1, Camera 2.

FIGURE IV-C-2. Black and White IR Image #2, Camera 2.

FIGURE IV-C-3. Black and White IR Image #3, Camera 2.

FIGURE IV-C-4. Black and White IR Image #4, Camera 2.

FIGURE IV-C-5. Black and White IR Image #5, Camera 2.

FIGURE IV-C-6. Black and White IR Image #6, Camera 2.

FIGURE IV-C-7. IR Image With Intensity Scale #1, Camera 1.

FIGURE IV-C-8. IR Image With Intensity Scale #2, Camera 1.

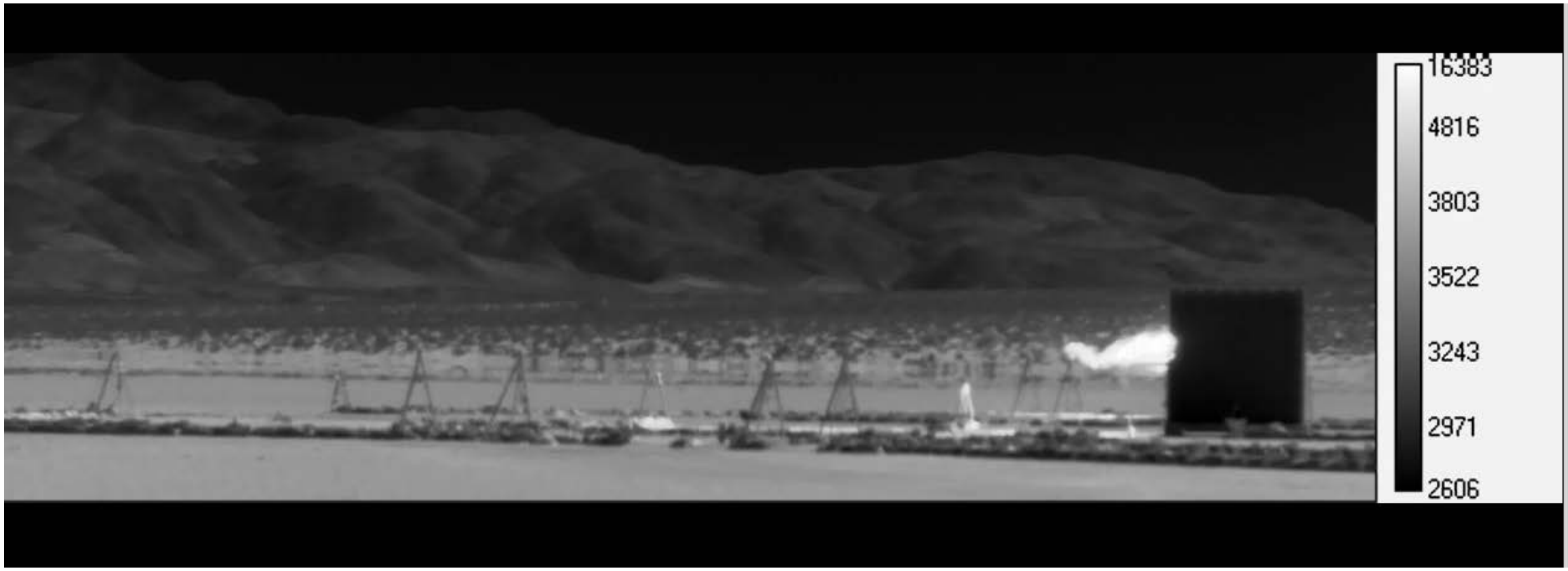

FIGURE IV-C-9. IR Image With Intensity Scale #3, Camera 1.

FIGURE IV-C-10. IR Image With Intensity Scale #4, Camera 1.

FIGURE IV-C-11. IR Image With Intensity Scale #5, Camera 1.

FIGURE IV-C-12. IR Image With Intensity Scale #6, Camera 1.

FIGURE IV-C-13. IR Image With Intensity Scale #7, Camera 1.

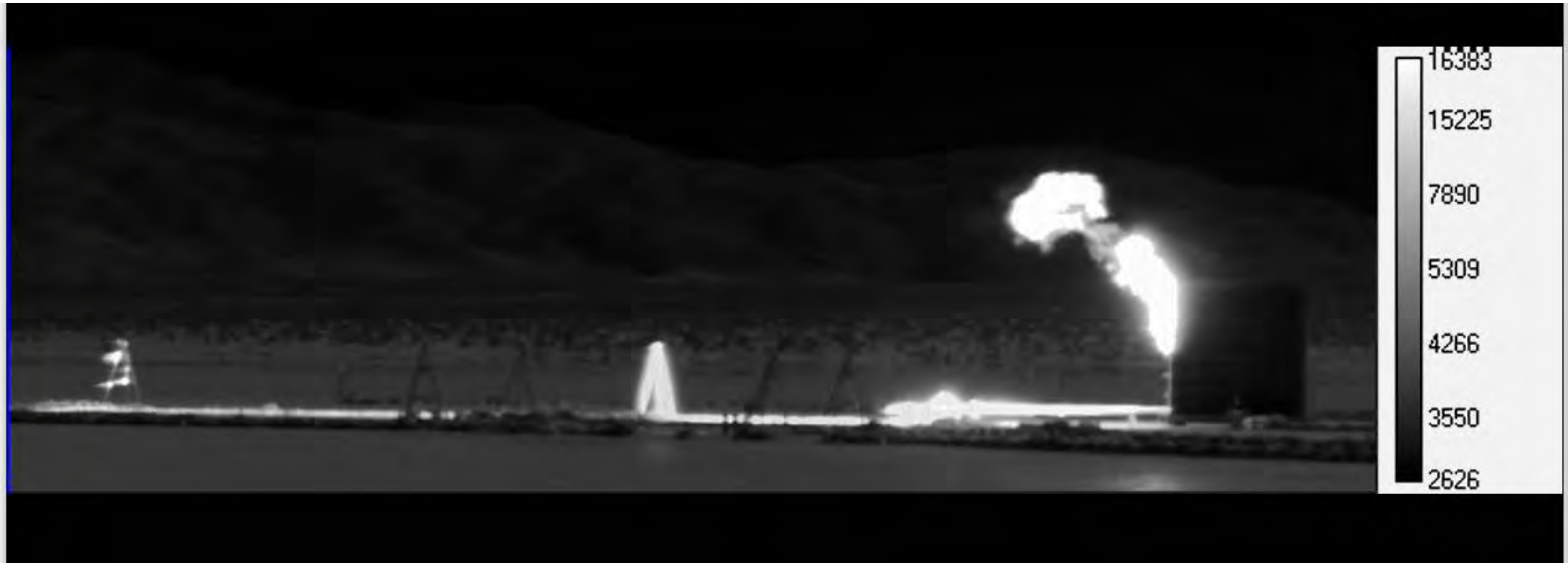

FIGURE IV-C-14. IR Image With Intensity Scale #8, Camera 1.

Appendix IV-D

HD1.3 TEST 3. HIGH-SPEED AND INFRARED VIDEOS

(See DVD for Appendix IV-D for High-Speed and IR Videos)

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CHAPTER V. TEST 4—CHOKED FLOW WITH THE LARGER M1 GRAIN

INTRODUCTION

Test 4 was conducted on 18 April 2013 at the West Airport Lake dry lake bed test site at the Naval Air Warfare Center Weapons Division (NAWCWD), China Lake, California. The structure used during the test was the same as that used in Test 3 with the exception of the closure plate with the 39-cm-diameter vent hole. This test was the last of four tests and was intended to begin to quantify the hazards of burning M1 propellant under choked flow conditions in a storage configuration. The data from the three previous tests were used to optimize the instrumentation setup for this test.

TEST DESCRIPTION

Test 4 had 1,108 pounds (503 kg) (versus the 1,176 pounds in Test 2) of the larger sized M1 propellant in eight fiberboard containers as shown in Figure V-1. The lids were removed in the image for placement of the igniters. The loading density of this test was 62.88 kg of propellant per m^3 of internal volume of the structure (0.06288 g/cm^3).

FIGURE V-1. Test 4 Structure With M1 Propellant Filled Barrels.

GAGE LOCATIONS

The Test 4 structure was instrumented to measure pressure, temperature, and heat flux within the structure as a function of time. The Test 4 interior gage locations are oriented as shown in Figure V-2 with the north opening of the structure facing the reader.

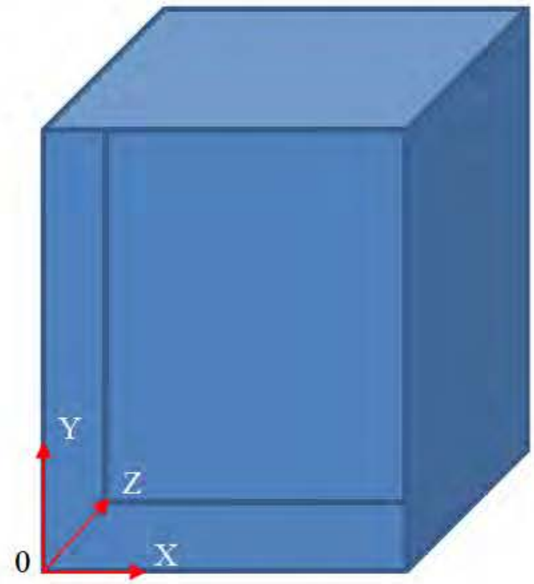

FIGURE V-2. Reference Figure for Internal Instrumentation.

The inside gage locations are presented in Table V-1 for Test 4. Outside gage locations are given in Figure V-3.

TABLE V-1. Gage Descriptions Inside Structure for Test 4.

Gage	ID	Location, inches			Comments
		x	y	z	
Thermocouple	1	78.72	59.22	61.47	West wall, top, south (top far corner*)
Thermocouple	2	78.72	60.72	19	West wall, top, north (top near corner*)
Thermocouple	3	78.72	56.97	61.47	West wall, bottom, south (bottom far corner*)
Thermocouple	4	78.72	57.97	17.25	West wall, bottom, north (top near corner*)
Thermocouple	5	76.22	70.22	76.22	South wall, top, west (upper right corner*)
Thermocouple	6	76.97	8.75	76.22	South wall, bottom, west (lower right corner*)
Thermocouple	7	39.36	39.36	74.72	Centered on south wall
Thermocouple	8	1.5	69.97	76.22	South wall, top, east (upper left corner*)
Thermocouple	9	2	8.5	75.97	South wall, bottom, east (lower left corner*)
Thermocouple	10	3	69.97	2.75	North wall, top, east (upper left corner*)
Thermocouple	11	1.75	8.5	2	North wall, bottom, east (lower left corner*)
Thermocouple	12	39.25	76.47	8.75	North wall, top, center (above door)
Thermocouple	13	39.97	8.75	2	North wall, bottom, center (below door)
Thermocouple	14	76.22	69.97	2.5	North wall, top, west (upper right corner*)
Thermocouple	15	76.47	8.75	2.75	North wall, bottom, west (lower right corner*)
Thermocouple	16	35	75.72	38.75	Centered on roof
Thermocouple	17	36.5	8.25	39	Centered on floor
Thermocouple	18				On barrel
Thermocouple	19				On barrel
Thermocouple	20				On barrel
DFT	16	0	41.22	40.22	East wall centered
DFT	17	78.72	47.97	35	west wall centered
Pressure	PI-1	75.72	37	29.75	West wall centered
Pressure	PI-2	75.72	37	35	West wall centered - baseline gage
Pressure	PI-3	36.5	39.47	75.72	South wall centered
Pressure	PI-4	3.25	41.22	40.22	East wall centered
Pressure	PI-5	35	75.72	39	Roof centered
Pressure	PI-6	36.5	3	39	Floor centered

*Looking into structure from north facing door.

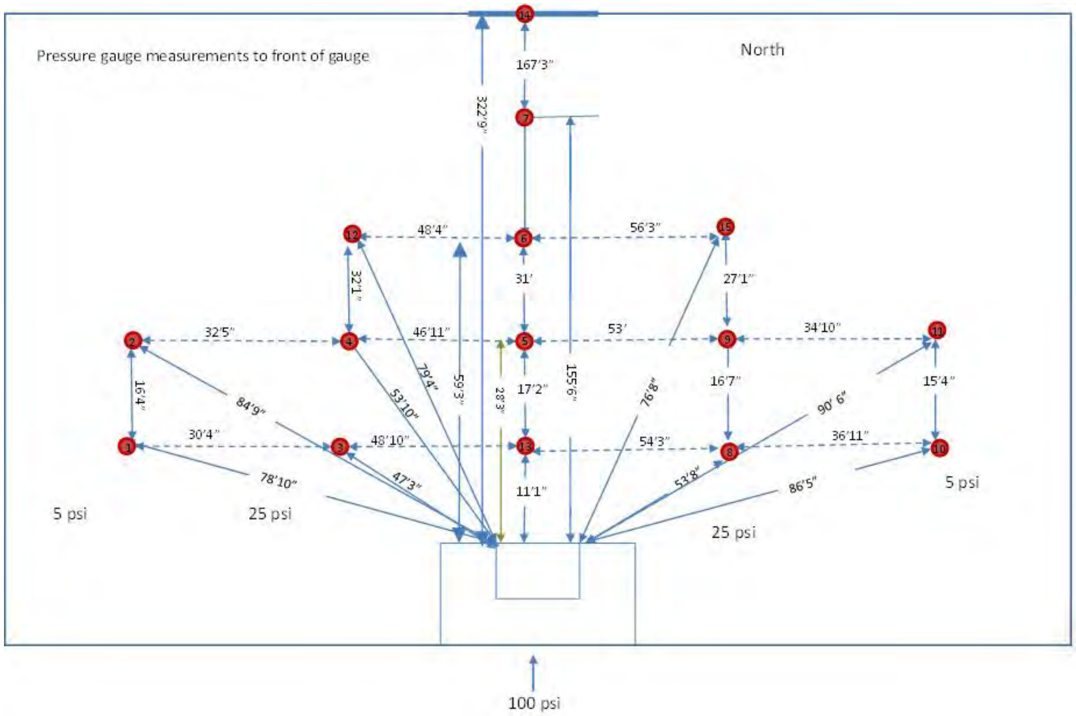

FIGURE V-3. Outside Gage Locations for Test 4.

TEST RESULTS

INSIDE STRUCTURE

The pressure–time data for pressure transducers 1, 3, 4, and 5 are shown in Figure V-4. There was excellent agreement between the traces. Figure V-4 shows choked flow at about 1.2 seconds after igniter activation, pressure rupture at 2.264 to 2.267 seconds, and a maximum internal pressure of 33.89 psi. The pressure data for Test 4 can be found in Appendix V-A.

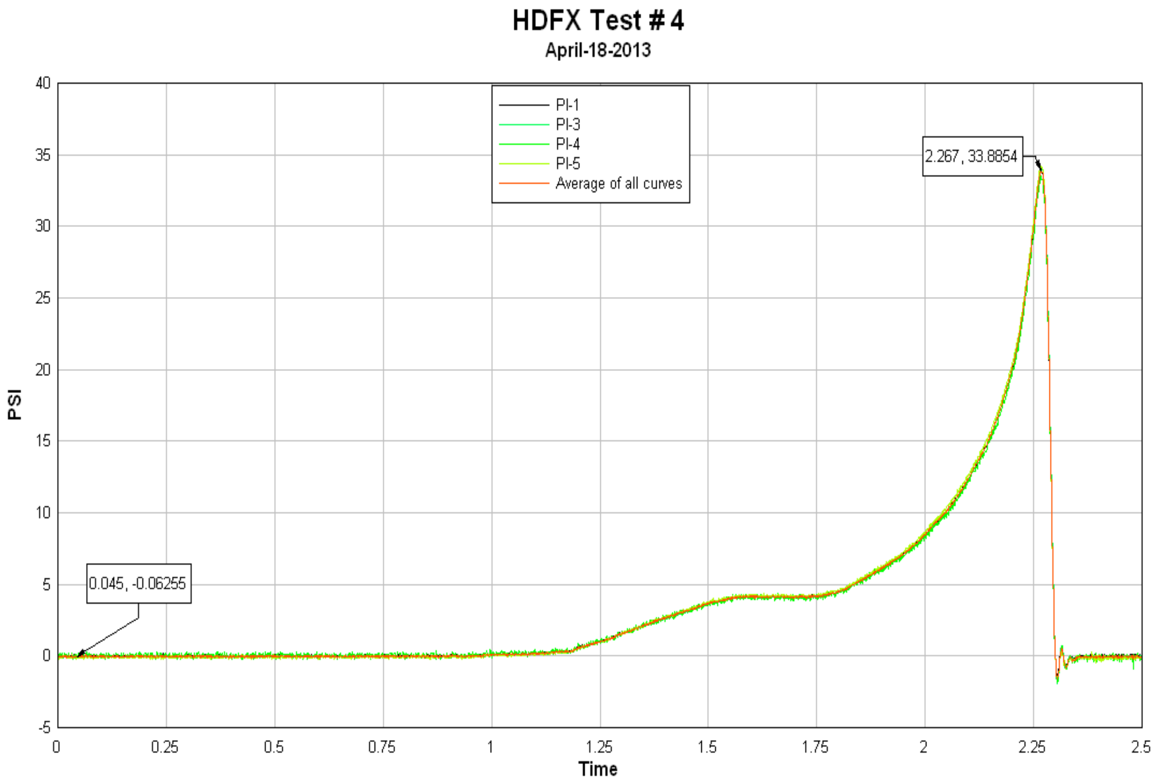

FIGURE V-4. Pressure–Time Plots Showing Excellent Agreement Between Four Transducers (Test 4).

Internal thermocouples TC-10, TC-8, TC-16, TC-14, and TC-12 (Figure V-5) all displayed very similar behavior. They all rose very quickly to over 1,250°C in about 2.5 seconds, indicating vigorous combustion of the gun propellant in those locations. The upper limit of type K thermocouples is 1,250°C, resulting in a burned out thermocouple for these channels after 2.5 seconds. Thermocouples TC-7, TC-4, and TC-5 (Figure V-6), in contrast, all near the bottom of the west wall, rose to a relatively low temperature within a few seconds (475°C at 2.33 seconds, 378°C at 2.65 seconds, and 153°C at 4.69 seconds, respectively), decreased slightly, and then increased to a higher temperature at more than 14 seconds (847°C at 14.6 seconds, 531°C at 18.3 seconds, and 721°C at 16.2 seconds, respectively). This reaction indicates less combustion of the gun propellant in this area until the rupture of the structure and then continued combustion of the gun propellant in that area after the structure failed. All of the temperature–time plots are presented in Appendix V-B.

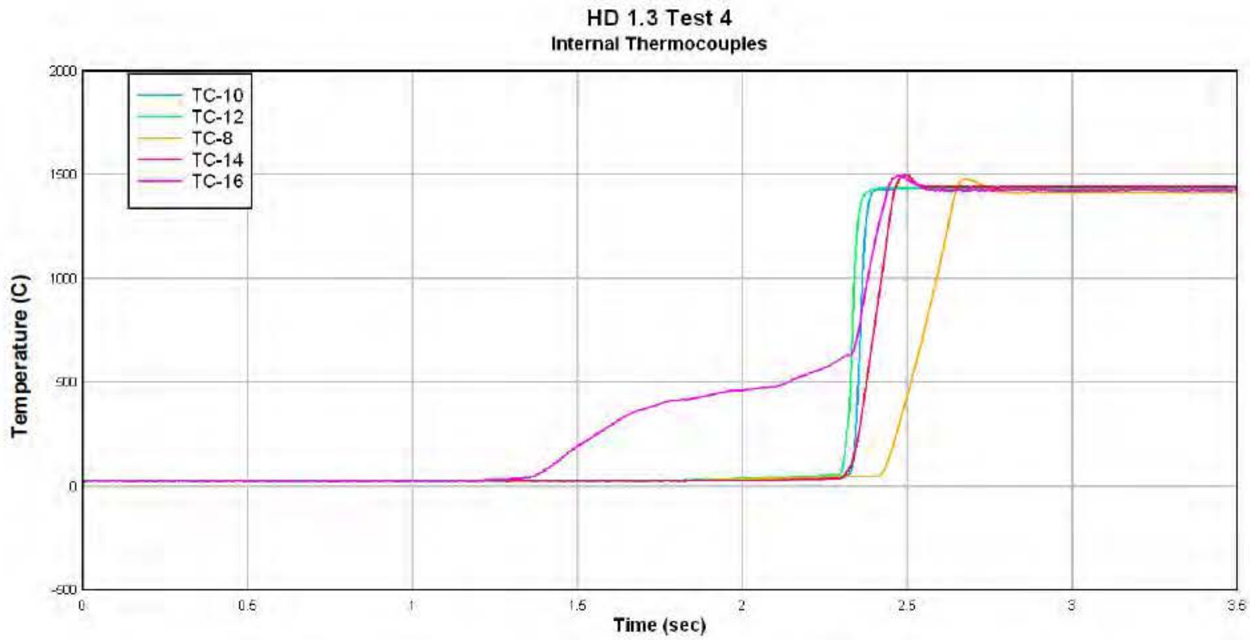

FIGURE V-5. Temperature–Time Plots Showing Excellent Agreement Between Five Transducers (Test 4).

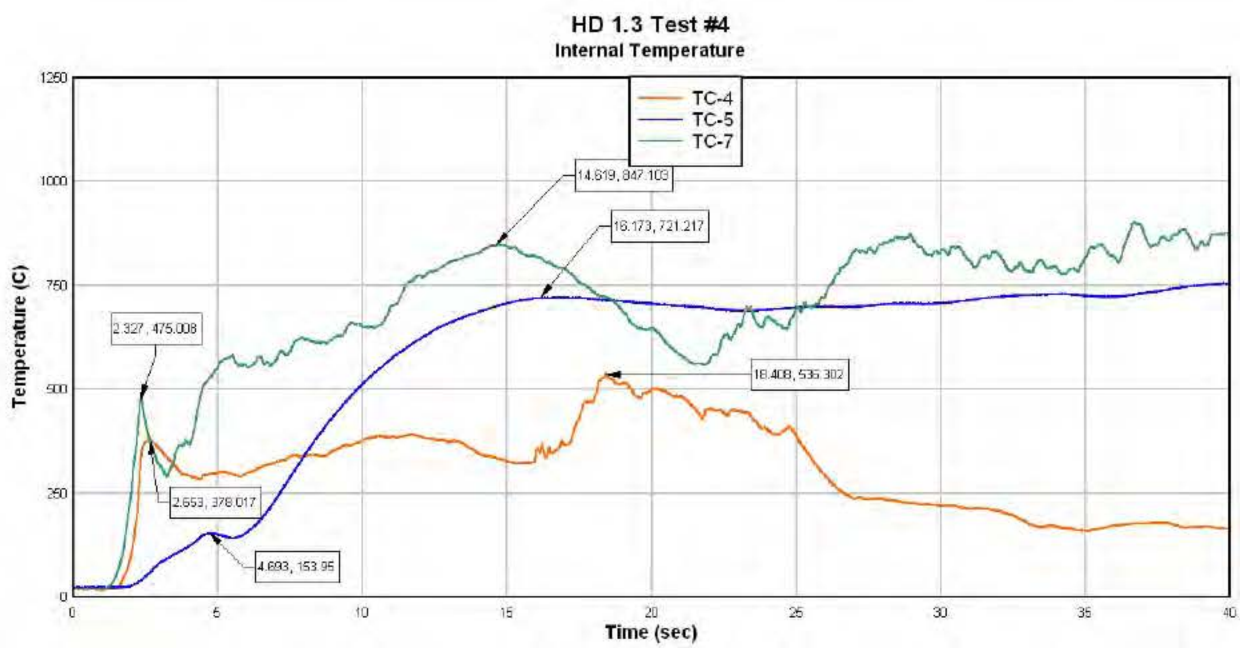

FIGURE V-6. Temperature–Time Plots Showing Temperature Oscillation Within Structure (Test 4).

Table V-2 provides a summary of the internal thermocouple readings with peak temperatures and correlated times from ignition.

TABLE V-2. Temperature–Time Results for Thermocouples Located at Top of Structure (Test 4).

Thermocouple	Location	Initial Rise	Maximum Temperature–Time
TC-1	West wall, upper south side	665°C at 2.43 s	1,116°C at 11.14 s
TC-2	West wall, upper north side	443°C at 2.67 s	552°C at 18.8 s
TC-3	West wall, lower south side	739°C at 2.43 s	739°C at 2.43 s
TC-4	West wall, lower north side	378°C at 2.65 s	536°C at 18.4 s
TC-5	South wall, upper west side	154°C at 4.69 s	816°C at 51.14 s
TC-6	South wall, lower west side	143°C at 8.1 s	143°C at 8.1 s
TC-7	South wall, centered	475°C at 2.33 s	1,005.4°C at 54.02 s
TC-8	South wall, upper east side	Rapid rise above 1,250°C at ~2.5 s	Above 1,250°C at ~2.5 s
TC-9	South wall, lower east side	Slow rise to 358°C at 15.9 s	358°C at 15.9 s
TC-10	North wall, upper east side	Rapid rise to above 1,250°C at ~2.5 s	Peaked above 1,250°C at ~2.5 s
TC-11	North wall, lower east side	240°C at 9.25 s	415°C at 10.7 s
TC-12	North wall, upper center	Rapid rise to above 1,250°C at ~2.5 s	Peaked above 1,250°C at ~2.5 s
TC-13	North wall, lower center	Slow rise to 589°C at 19 s	589°C at 19 s
TC-14	North wall, upper west side	Rapid rise to above 1,250°C at ~2.5 s	Peaked above 1,250°C at ~2.5 s
TC-15	North wall, lower west side	Slow rise to 340°C at 11.4 s	340°C at 11.4 s
TC-16	Roof, centered	Rapid rise to above 1,250°C at ~2.5 s	Above 1,250°C at ~2.5 s
TC-17	Floor, centered	334°C at 2.7 s	531°C at 5.25 s
TC-18	On the barrels	293°C at 2.37 s	839°C at 18.8 s
TC-19	On the barrels	445.6°C at 2.55 s	445.6°C at 2.55 s
TC-20	On the barrels	576°C at 2.73 s	665°C at 6.31 s

There were also thermocouples attached to the drums of propellant (TC-18, TC-19, TC-20). Thermocouple TC-20 had two peaks at 576°C at 2.7 seconds and 665°C at 6.2 seconds. Thermocouple TC-19 had a single peak at 446°C at 2.56 seconds.

Figure V-7 presents the heat flux data taken in the interior of the structure. The data for Test 4 have the time scale with time zero being the pulse to the igniters. The data show the heat flux recorded on the east wall (16) and the west wall (17). The difference in heat flux between the east and west walls may be an additional indication that combustion of the gun propellant near the west wall was less when compared to the

propellant combustion at the south and east walls. This correlates with the discussed results presented in the temperature–time data previously stated. Additional heat flux can be found in Appendix V-B.

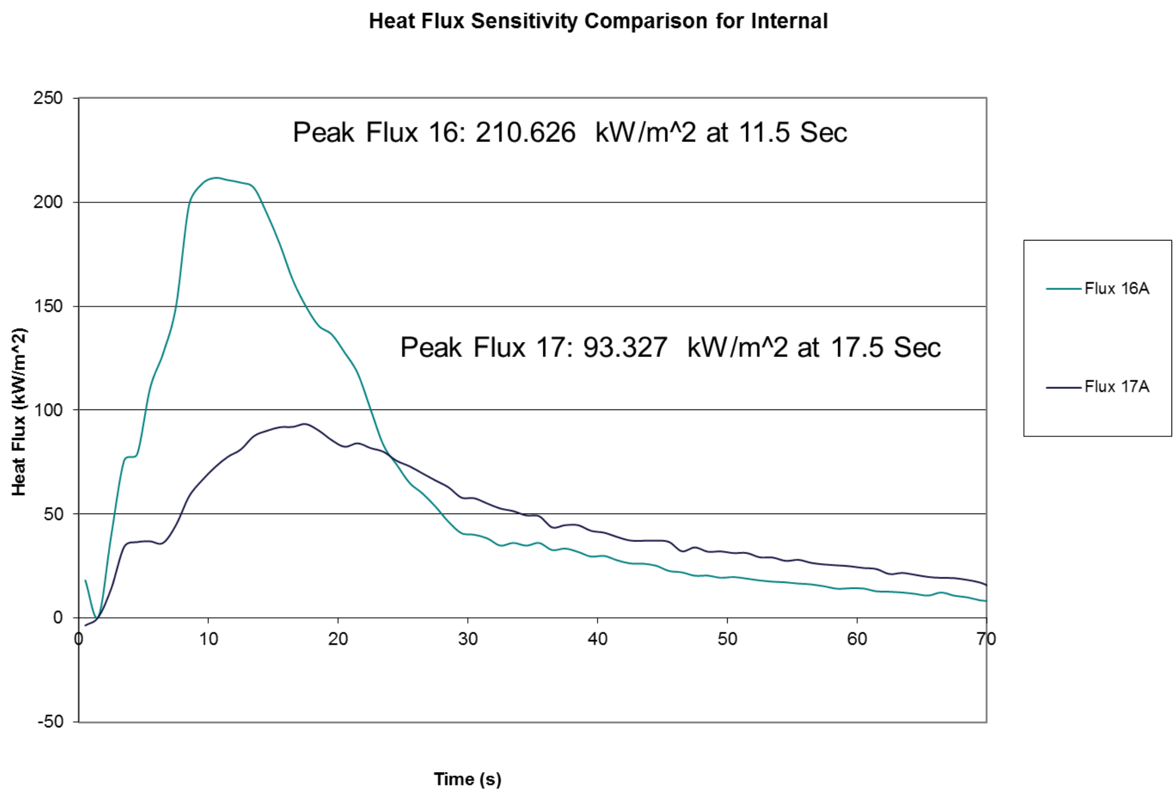

FIGURE V-7. Heat-Flux Recordings From Interior of Structure (Test 4).

The maximum internal heat flux was 210.63kW/m^2 and was recorded at 11.5 seconds. Note that the flux on both walls increased after rupture of the structure at approximately 2.27 seconds, indicating that the gun propellant was experiencing increased mass burning/heat flux after the rupture.

The following photographs present post-test views from the inside of the structure. Figure V-8 presents a view of the west wall (right), south wall (bottom left), what is left of the roof (top left), and the rebar where the roof attached to the west wall. Figure V-9 presents the east wall (lower left), south wall (lower right with piece of conduit), and roof (upper portion of figure). Daylight is visible where the roof joined the east wall but not at the south wall-roof junction in this figure.

FIGURE V-8. West Wall (Right), South Wall (Lower Left), Roof (Upper Left), and Rebar That Had Attached Roof to West Wall (Test 4).

FIGURE V-9. East Wall (Lower Left), South Wall (Lower Right With Conduit) and Roof (Upper Portion of Figure) (Test 4).

Figure V-10 shows the remains of the drums that held the M1 propellant, indicating that all of the propellant burned. The thermal, pressure, and video data from this test support the theory that much of the propellant burned after the structure failed.

FIGURE V-10. Remains of Drums That Contained M1 Propellant (Test 4).

OUTSIDE STRUCTURE

The pressure transducers outside the structure recorded low levels of pressure. The highest pressure was 1.69 psi (Figure V-11) for PO-7, located 155.5 feet in line from the north structure face (along centerline).

A lesser peak is observed in most of the external pressure gages between 2.32 and 2.4 seconds (Figure V-12 and Table V-3). This spike occurs at a similar time as the initial thermal spike and peak pressure observed inside the structure. The gage locations determine how quickly the pressure is recorded by each gage. Gages farther from the event recorded a pressure change at a slightly longer time.

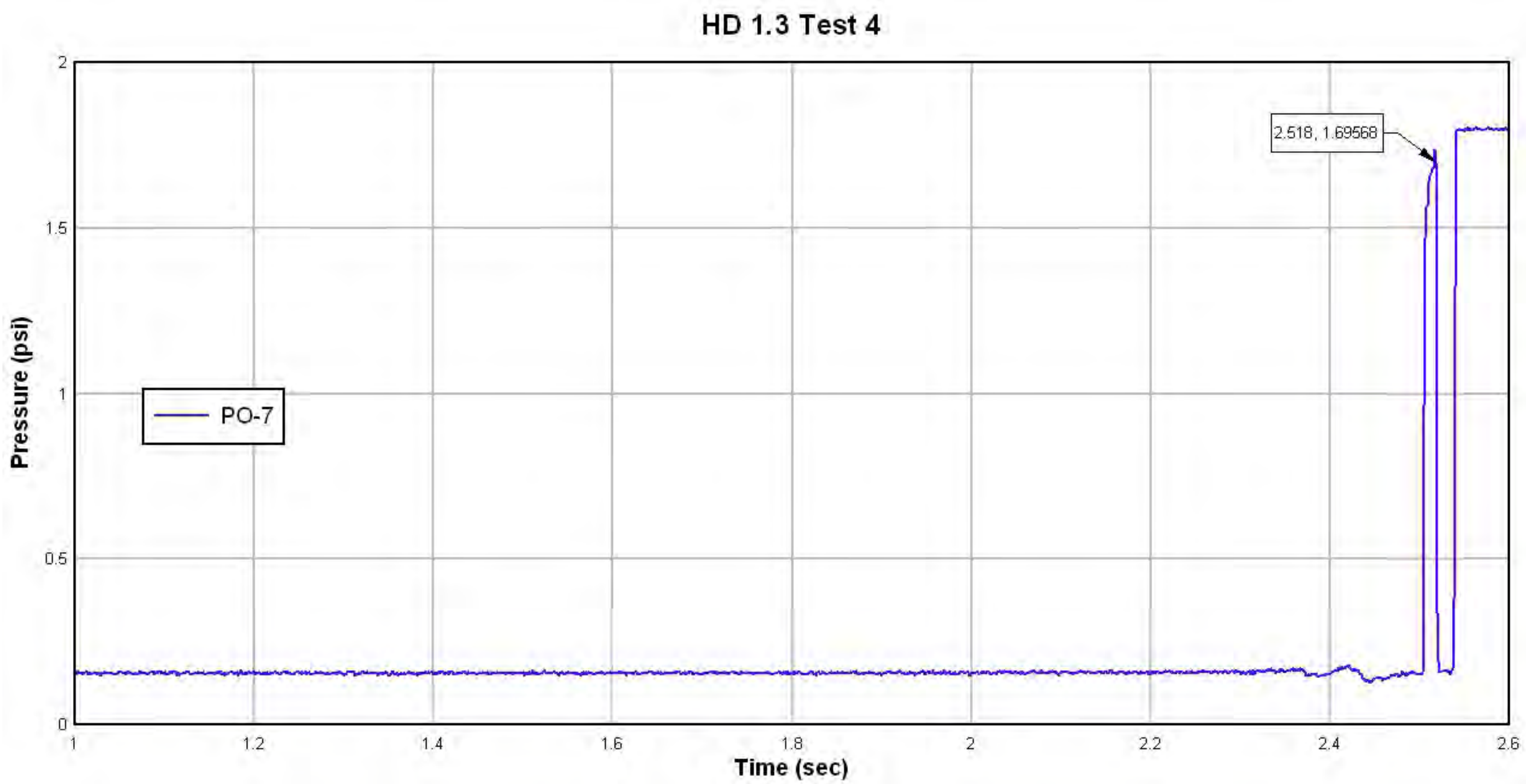

FIGURE V-11. Plot of Highest Outside Pressure Data (Test 4).

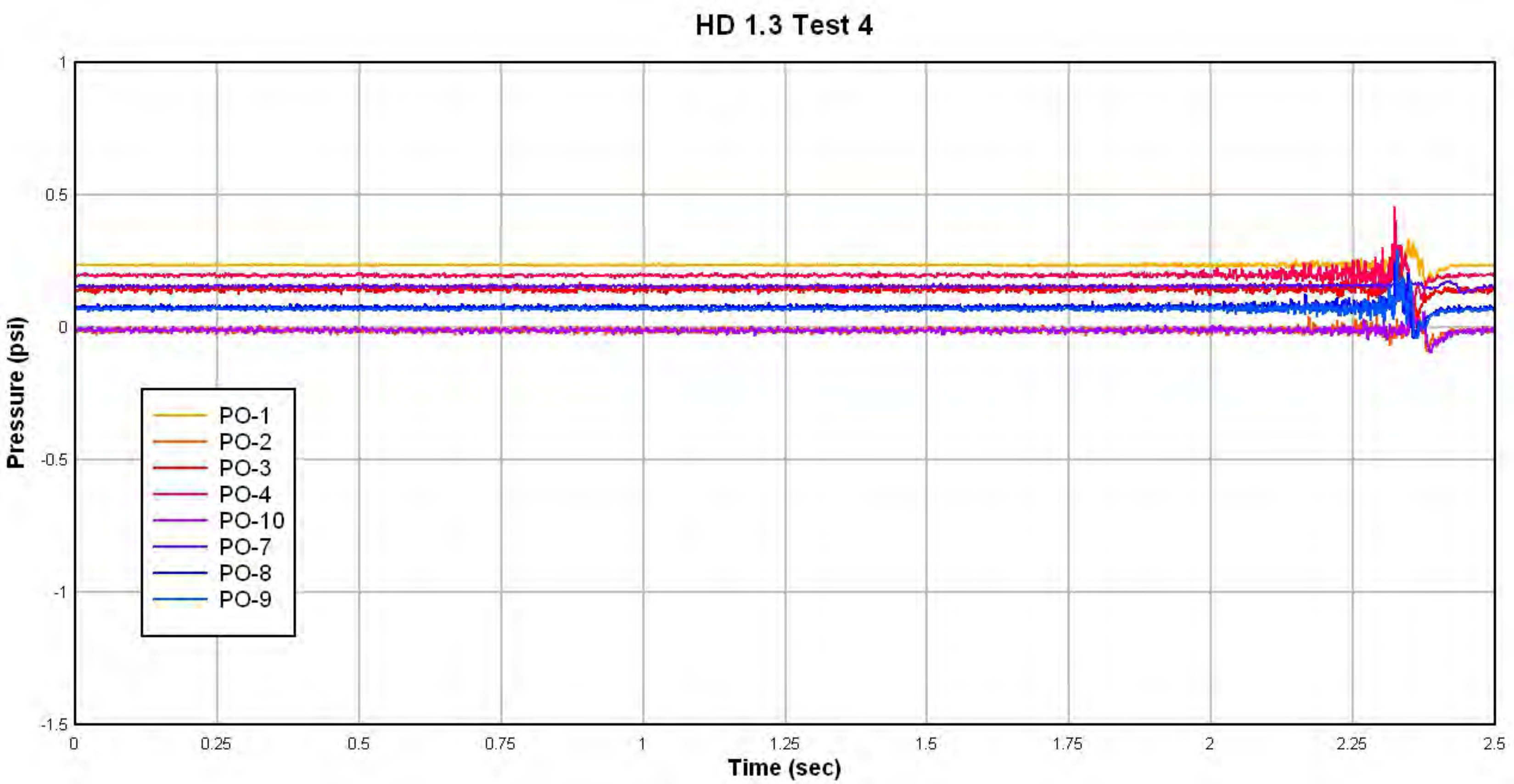

FIGURE V-12. Plot of Correlated Peaks at 2.33 Seconds
From Outside Pressure Data (Test 4).

TABLE V-3. Pressure–Time Results for External Thermocouples at ~2.3 Seconds (Test 4).

Gage Number	Time, s	Pressure, psi
1	2.35	0.28
2	2.35	0.07
3	2.33	0.22
4	2.33	0.27
7	2.42	0.18
8	2.33	0.25
9	2.34	0.20
10	2.35	0.10

The heat fluxes measured exterior to the structure are shown in Figure V-13. A maximum measured flux of approximately 1,137.897 kW/m^2 was measured at heat flux gage 13, located 11 feet, 1 inch from the north wall, at approximately 13.5 seconds inside of the fireball.

A flux of 1.5492 kW/m^2 was measured at DFT 14 at 2.5 seconds. Figure V-14 presents the heat flux plot for the data from DFT 14. This DFT was 322 feet 9 inches from the north wall of the structure (along centerline). The peak heat flux measured from that DFT was 4.236 kW/m^2 at 5.5 seconds.

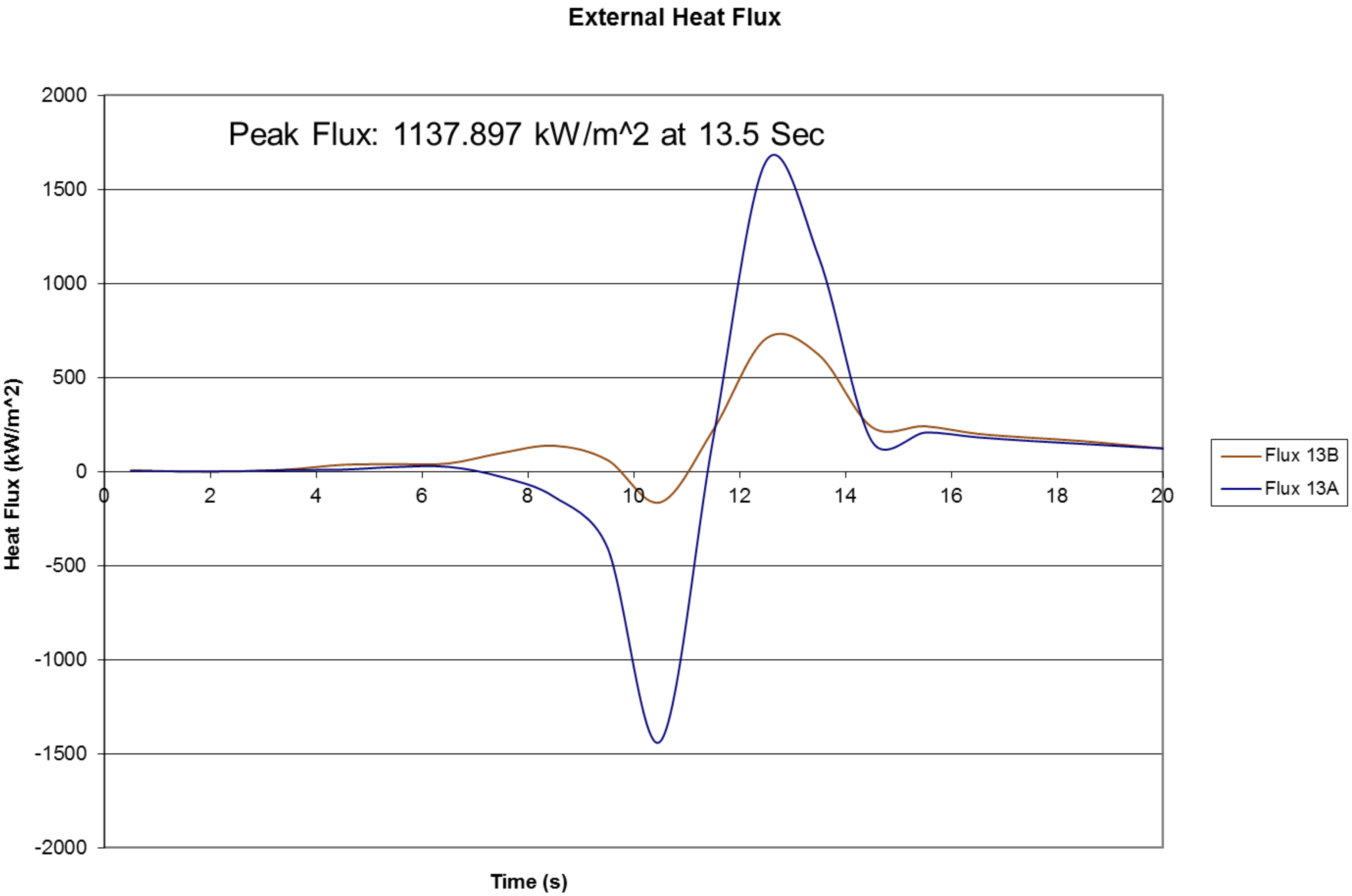

FIGURE V-13. Heat Fluxes Measured Exterior to Structure at Gage 13 (Test 4).

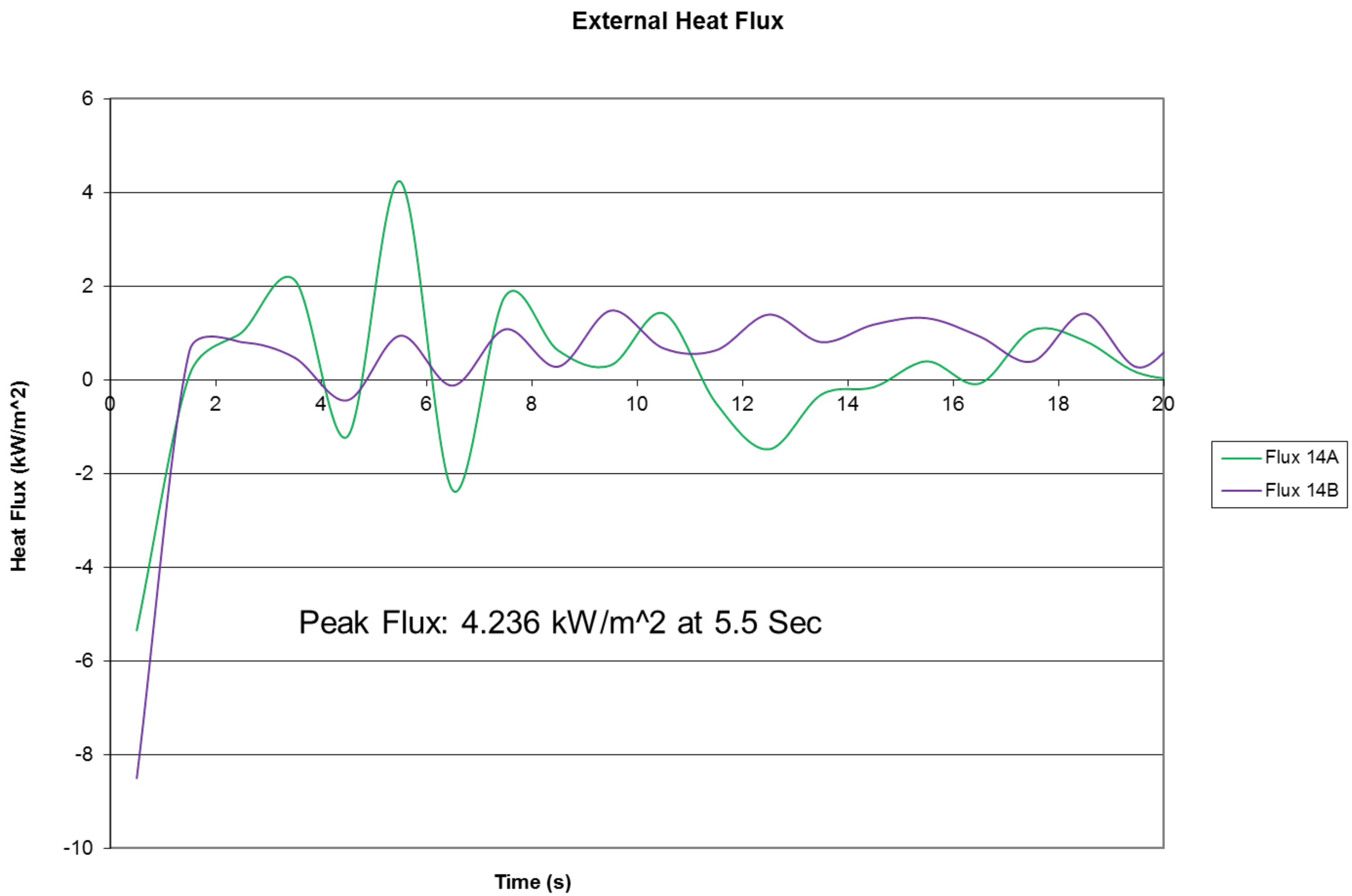

FIGURE V-14. Heat-Flux Data From DFT 14 (Test 4).

Figures V-15 through V-17 depict digital photographs of the fireball formation, taken from a vantage point above Airport Lake. Figure V-15 shows the rupture of the roof, fragment formation, and the beginning of the fireball formation.

FIGURE V-15. Rupture of Roof, Fireball Formation
and Debris Fragments Formed (Test 4).

FIGURE V-16. Further Development of Fireball (Test 4).

FIGURE V-17. Further Development of Fireball (Test 4).

Figures V-18 through V-24 present still pictures taken from the high-speed video of Test 4, showing the choked flow plume and the fireballs after rupture of the structure. Choked flow was observed by the internal pressure at ~1.25 second, with a vent area ratio of 0.029 and with 1,108 pounds of M1 propellant. Figure V-18 depicts the structure and plume under choked flow conditions, at 2 seconds from ignition, prior to structural failure. Figures V-19 through V-22 depict the change in the fireballs direction after the structure fails. The change in fireball direction can be correlated with the external flux measurements.

FIGURE V-18. Still Picture Taken From Video of Test 4 at 2 Seconds After Ignition Showing Plume Associated With Choked Flow.

FIGURE V-19. Still Picture From Video of Test 4 at 4 Seconds After Ignition Showing Fireball From Ruptured Structure.

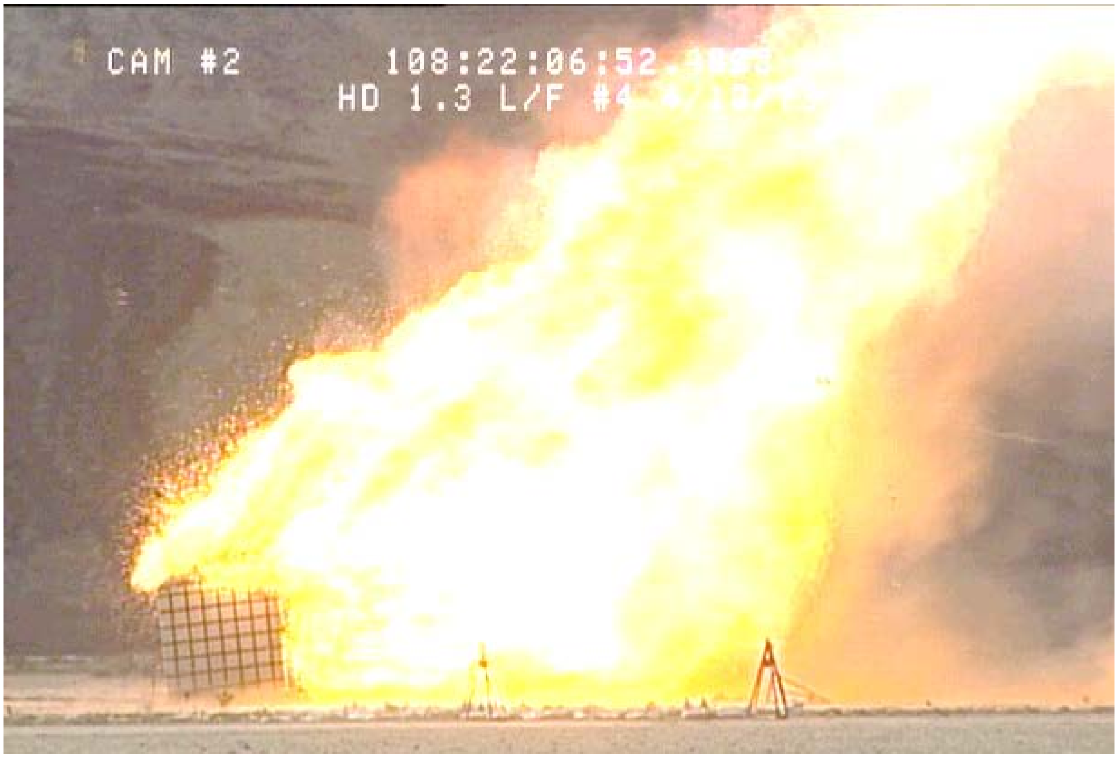

FIGURE V-20. Still Picture From Video Taken of Test 4 at 5 Seconds After Ignition.

FIGURE V-21. Still Picture Taken From Video of Test 4 at 7 Seconds After Ignition.

FIGURE V-22. Still Picture Taken From Video of Test 4 at 13 Seconds After Ignition.

FIGURE V-23. Still Picture Taken From Video of Test 4 at 14 Seconds After Ignition.

FIGURE V-24. Still Picture Taken From Video of Test 4 at 20 Seconds After Ignition.

A timeline for the Test 4 events was developed using the IRIG timing to align the time sampling from the instrumentation, real-time video, and high-speed camera. The Test 4 time sequence of events is summarized in Table V-4, with the detailed timeline given in Appendix V-C.

TABLE V-4. Summary Overview (Test 4).

Approximate Time, s	Event
0	Ignition pulse to propellant
1.14	Flamelet out orifice
1.2	Pressurization inside structure starts
1.25	1 pound per square inch gage (psig) pressure inside structure
1.42	Plume out orifice; diameter > orifice diameter
1.5	3.5 psig
1.75	Plume diameter ≈ orifice diameter
1.75	4.0 psig
1.8	5.0 psig
1.85	6.0 psig
1.9	Smoke starting at roof/wall joints
1.92	Roof bulging
1.93	Fireball out of roof, lots of black smoke
1.95	Roof continue to rise, large fireball forming
1.95	8.0 psig
1.96	Roof beginning to fracture
1.99	Fractures coalesce and fragments form
2	Fully choked flow
2	9 psig
2	Roof fragments produced and move out, walls expanding at top fireball out north wall
2.07	Door ≈60 degrees from vertical
2.1	13 psig
2.11	Structure rotating, door almost horizontal
2.15	15 psig
2.2	20 psig
2.25	30 psig
2.267	33.89 psig, structure ruptures
2.37	Rupture of structure pressure drops rapidly
2.71	Lots of fragments form roof and walls, pieces of rebar
2.79	Fireball really intense, lots of burning particles
4.63	Large fragments “raining down”
6.93	Extremely intense fireball north of structure, many burning particles, flame out east wall near top
8.06	Still very intense fireball
8.58	Still very intense fireball
12.57	Few fragments, but intense fireball
14.93	Intense fireball
15.01	Fireball intensity starts to decrease
16.85	Faint flames, no longer white fireball
17.78	Very diminished cellular flames

Figure V-25 presents a photograph of the structure remaining after the test. Clearly shown are what is left of the roof, the door frame with orifice plate on the ground in front of the structure, the deformed north (front) wall, and the west wall. The following photographs show more details of the other walls and fragments.

FIGURE V-25. Structure Remaining at End of Test 4.

Figure V-26 presents the east wall and north wall showing that the structure had "rocked back" during the test, as was observed in the high-speed videos of the test (Appendix V-D).

FIGURE V-26. East and North Walls Post-Test Structure (Test 4).

Figure V-27 shows what was left of the roof, the west wall, and the south wall. The damage to the south wall is indicated by the red color of the concrete. Part of the west wall was also damaged, as indicated by the green color. Again, there is evidence that the structure "rocked back" during the test.

FIGURE V-27. West Wall, South Wall, and Damaged Roof (Test 4).

Figure V-28 shows a detail of the area where the roof, the west wall, and south wall were joined.

FIGURE V-28. Close-Up Photograph Showing Damage at Roof, South Wall (Red), West Wall (Green Attached Fragment) (Test 4).

Figures V-29 and V-30 show the west wall after the test. The damage to the roof is evident as is the damage at the west wall/south wall junction (right), and the west wall/north wall junction (left).

FIGURE V-29. West Wall Post Test (Test 4).

FIGURE V-30. West Wall and Damaged Roof After Test 4.

Figure V-31 shows the damage at the west wall (right)/north wall (left) junction. The crack shown at the bottom of the photograph extended all the way down the wall.

FIGURE V-31. Damage at North Wall (Left)/ West Wall (Right) Junction at End of Test 4.

Figure V-32 shows the crack in the south wall near the south wall (left)/east wall (right) corner at end of Test 4.

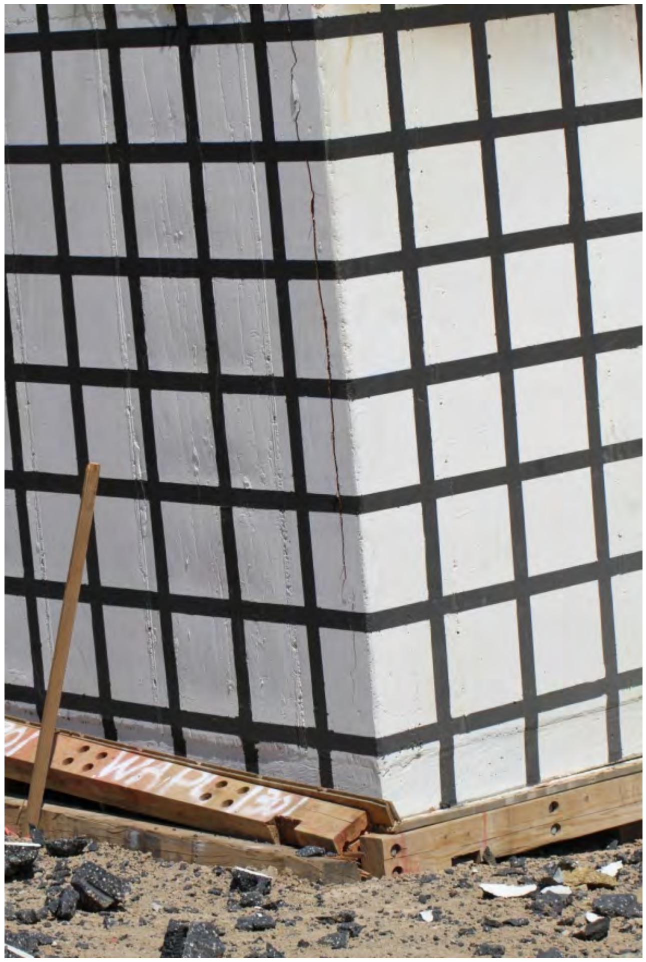

FIGURE V-32. South Wall (Left)/East Wall (Right)
Corner With Crack in South Wall (Test 4).

Figure V-33 shows the east wall/north wall/roof junction, and Figure V-34 shows a close-up view of east wall roof/north wall junction.

FIGURE V-33. East Wall/North Wall Roof Junction at End of Test 4.

FIGURE V-34. Close-Up of East Wall Roof/North Wall Junction (Test 4).

Doppler Radar

Doppler radar captured the velocity of the plume in Test 4. The plume was detected for 16 seconds total with an initial velocity of 72 meters per second. The velocity of the plume peaked at 342 meters per second before retreating into the structure at a velocity of 245 meters per second. Individual fragments were detected by the radar. A maximum fragment velocity of 130 meters per second was determined. Figure V-35 provides an intensity profile of the plume in Test 4. Additional intensity profiles can be found in Appendix V-E.

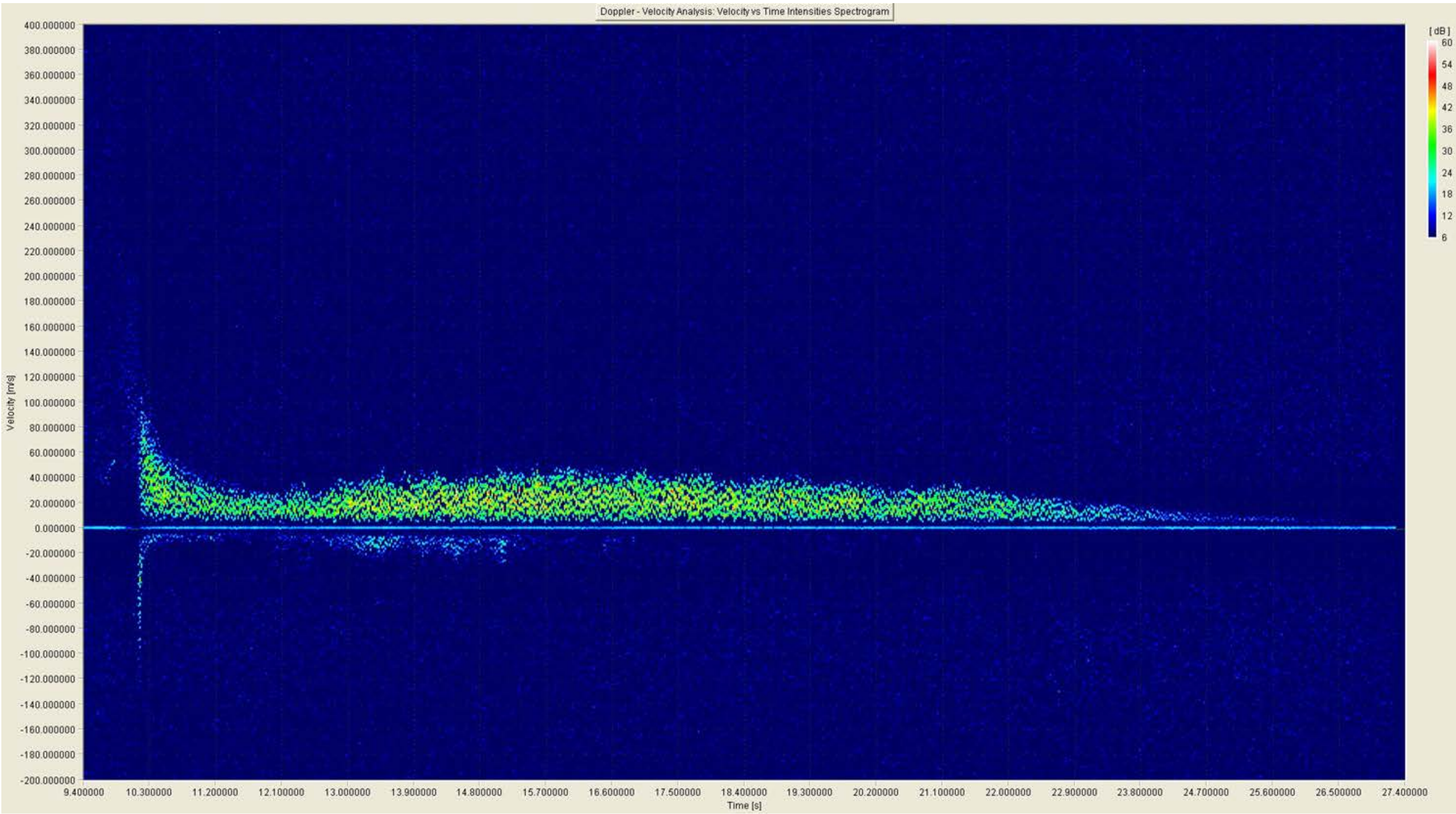

FIGURE V-35. Doppler Intensity Profile (Test 4).

Infrared (IR) Cameras

In this test, the IR cameras were used get an overall thermal signature of the event. The cameras were calibrated prior to the event and filters were used to prevent washout of the pixels. The calibration was done using a black body source set at two temperatures 100 and 232°C. Figure V-36 is a frame taken from the video of the IR camera 2. Additional IR data can be found in Appendix V-F.

FIGURE V-36. IR Intensity Profile of Plume (Test 4).

The intensity scale shows that the maximum intensity observed by the camera was 16,383 where the pixels were saturated. This correlates to a maximum temperature of ~491°C, assuming that the temperature from the calibration scales linearly and that the emissivity of the air/gases within the plume and fireball are one. Figure V-37 shows an evaluation of the thermal profile using the profile tool in the forward-looking infrared (FLIR) software.

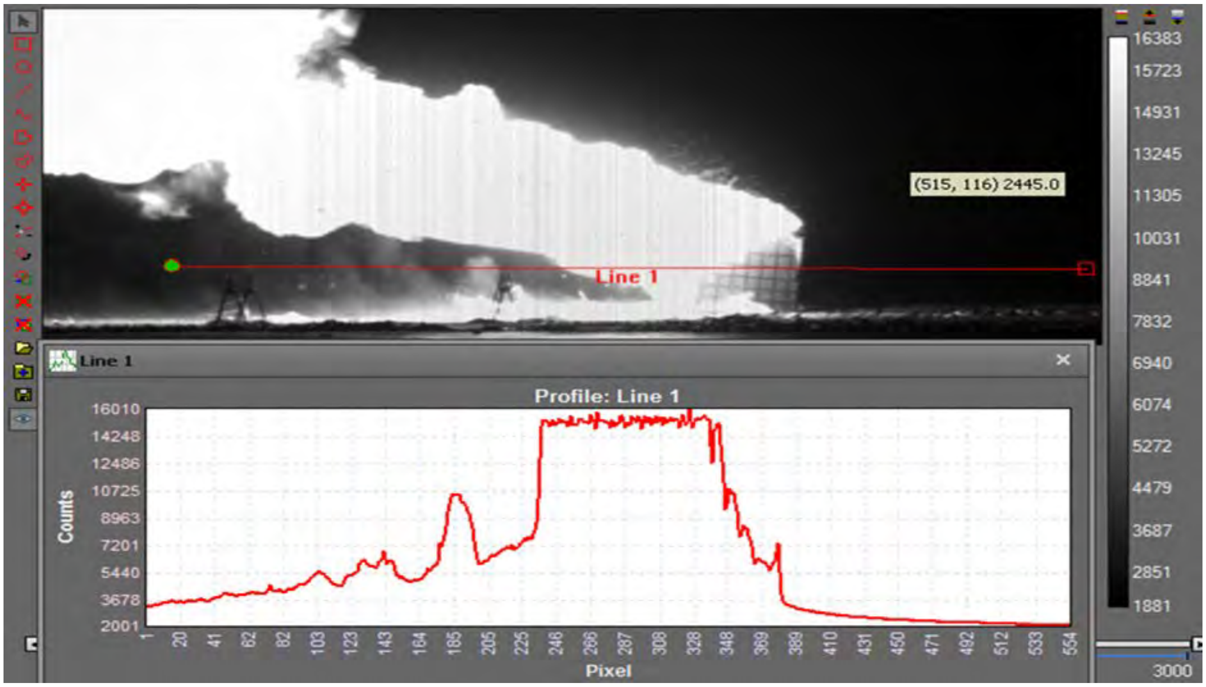

FIGURE V-37. IR Intensity Profile of Fireball (Test 4).

Using the line profile tool in the IR software, the intensity observed in a single line of pixels can be evaluated. The plateau in the profile chart indicated that the pixels were saturated in that location of the picture. It appears that at intensities above 15,000 (450°C) saturate the pixels. The intensity levels within the plume and fireball were measured above the 15,000 level, which indicates that the temperature was well above 450°C.

Structural Debris and Fragment Mapping

Figure V-38 shows the fragment map for Test 4. Test 4 produced fragments from all four walls and the roof. All fragments were mapped using the center of the structure as a zero point. The farthest fragment measured was 156 meters (512 feet) and was identified as part of the roof. Other fragments include a fragment from the roof at 120 meters (394 feet), a fragment from the west wall at 145 meters (476 feet), a fragment from the south wall at 136 meters (446 feet), and a fragment from the eastern wall at 126 meters (413 feet). Each of these fragments, as well as many others, landed beyond the IBD of 23 meters (75 feet) calculated for this test. Subsequent sections will discuss the recovered fragments in terms of their individual weights, what part of the structure they came from, and the location where they were found.

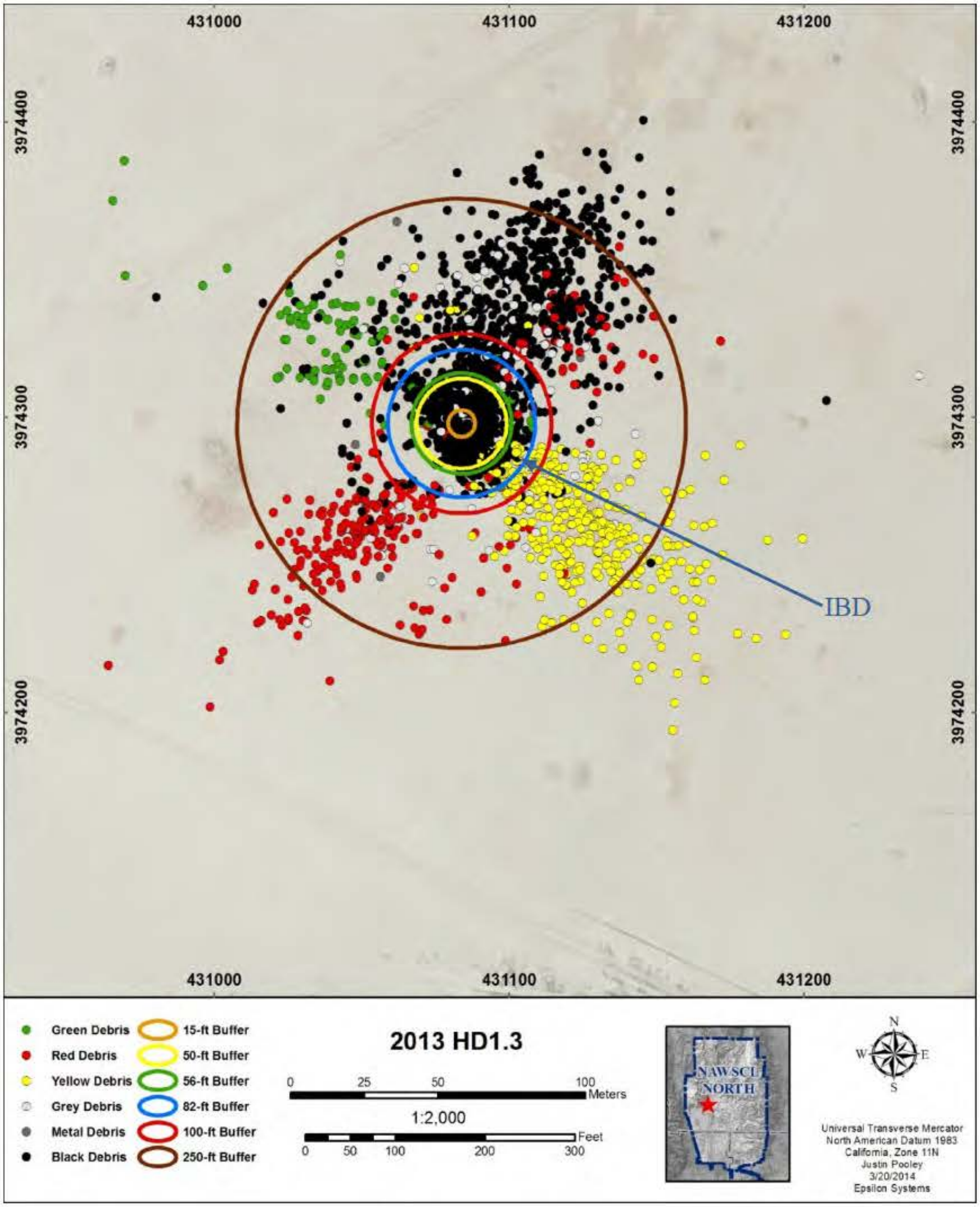

FIGURE V-38. Fragment Map of Test 4.

The number distribution of the collected fragments from Test 4 is shown in Figure V-39 with the corresponding weight distribution plot shown in Figure V-40.

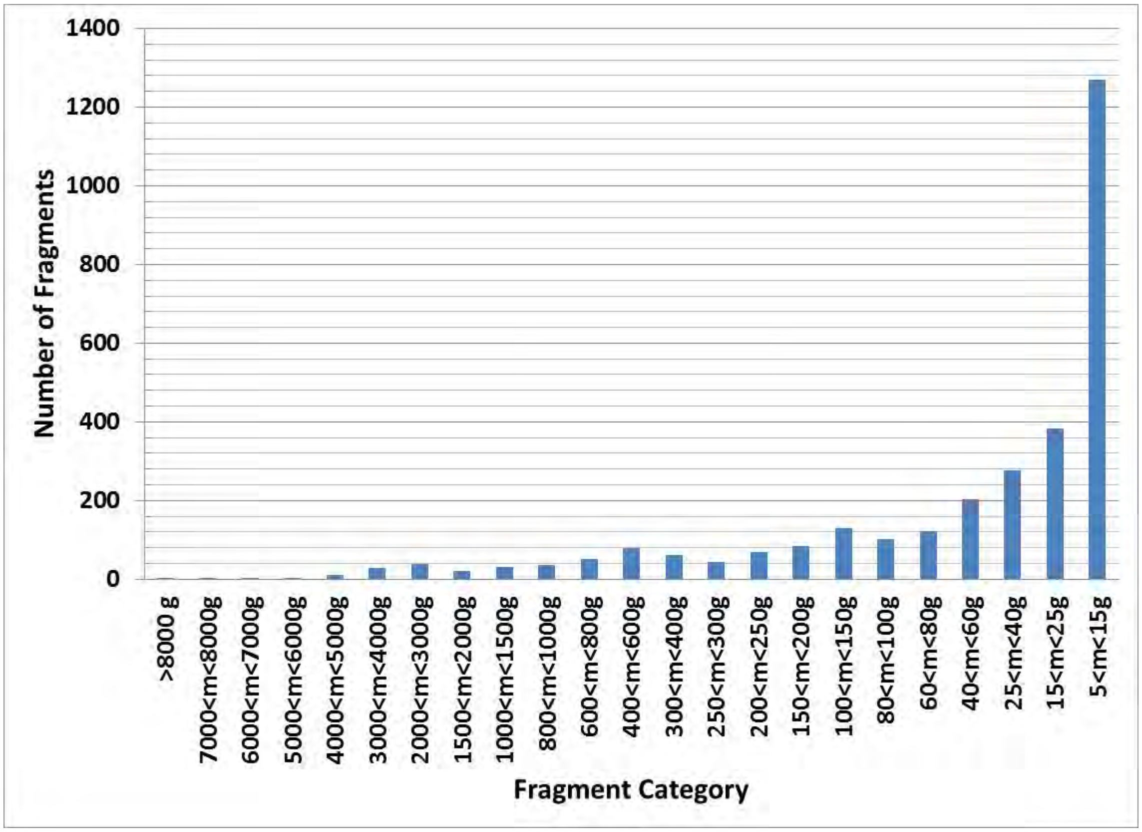

FIGURE V-39. Number Distribution by Weight Category (Test 4).

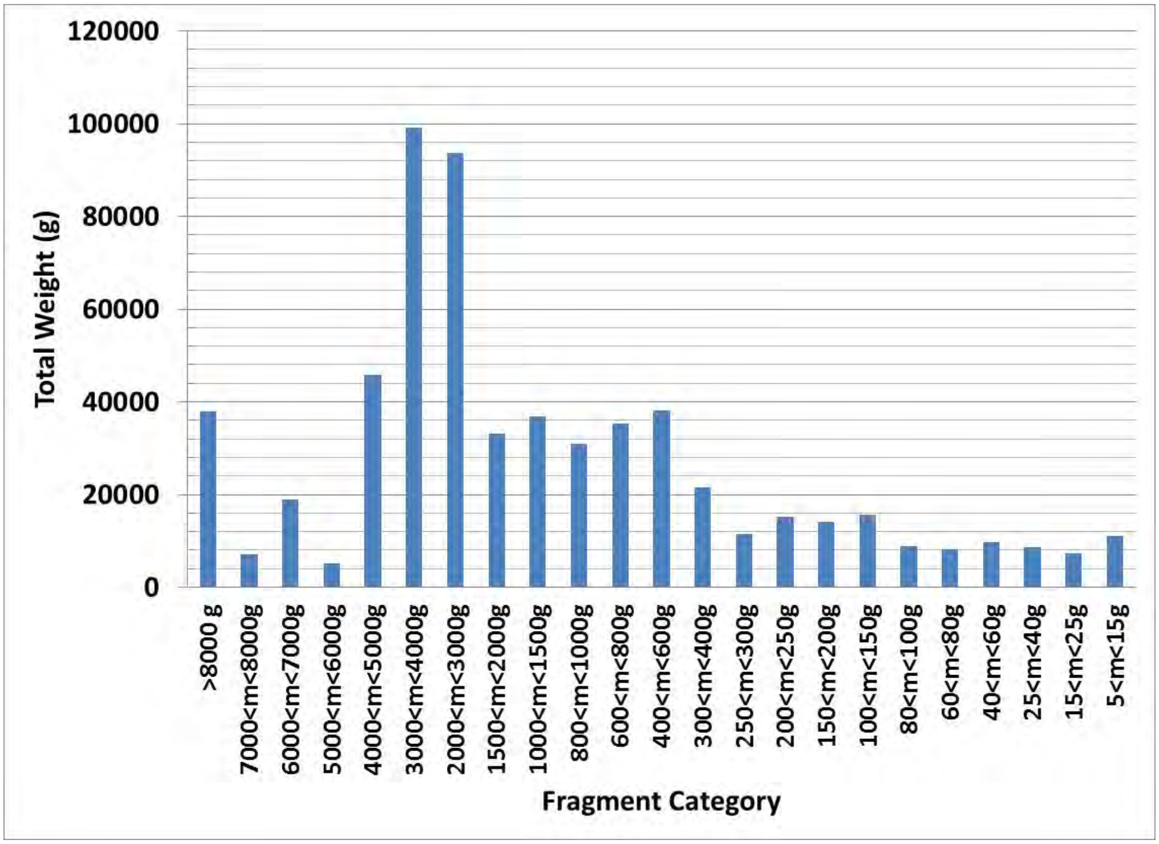

FIGURE V-40. Weight Distribution of Fragment Weight Group (Test 4).

As with the distributions for Test 2, the number distribution favors the smaller fragments. There are many smaller fragments [ca 1,275], but they do not have much weight. These 1,275 fragments produce a combined weight slightly more than 1 kg. In contrast, four fragments in the larger than 8-kg bin produce an accumulative weigh of approximately 37 kg, with the largest fragment weighing 11.555 kg.

All of the individual fragment maps for the various weight group previously shown are presented in Appendix V-G along with photographs of significant debris fragments. The fragment maps and photographs for debris fragments of 1,000 grams or greater, that were found outside the calculated IBD (23 meters or 75 feet), are shown in the following figures. Additional photographs of fragments have been included to convey unexpected or significant findings on how the structure failed.

The fragment map for fragments having weight greater than 8,000 grams is presented in Figure V-41. The largest fragment, weighing 11,555 grams, was found 31.5 meters (103 feet) from the center of the original structure. There are four fragments total in this category, the largest fragment came from the roof and is shown in Figure V-42. The other three large fragments having weights greater than 8,000 grams are shown in Figures V-43, V-44, and V-45. No fragments of weights 6,000 to 7,999 grams were found outside the calculated IBD (23 meters or 75 feet).

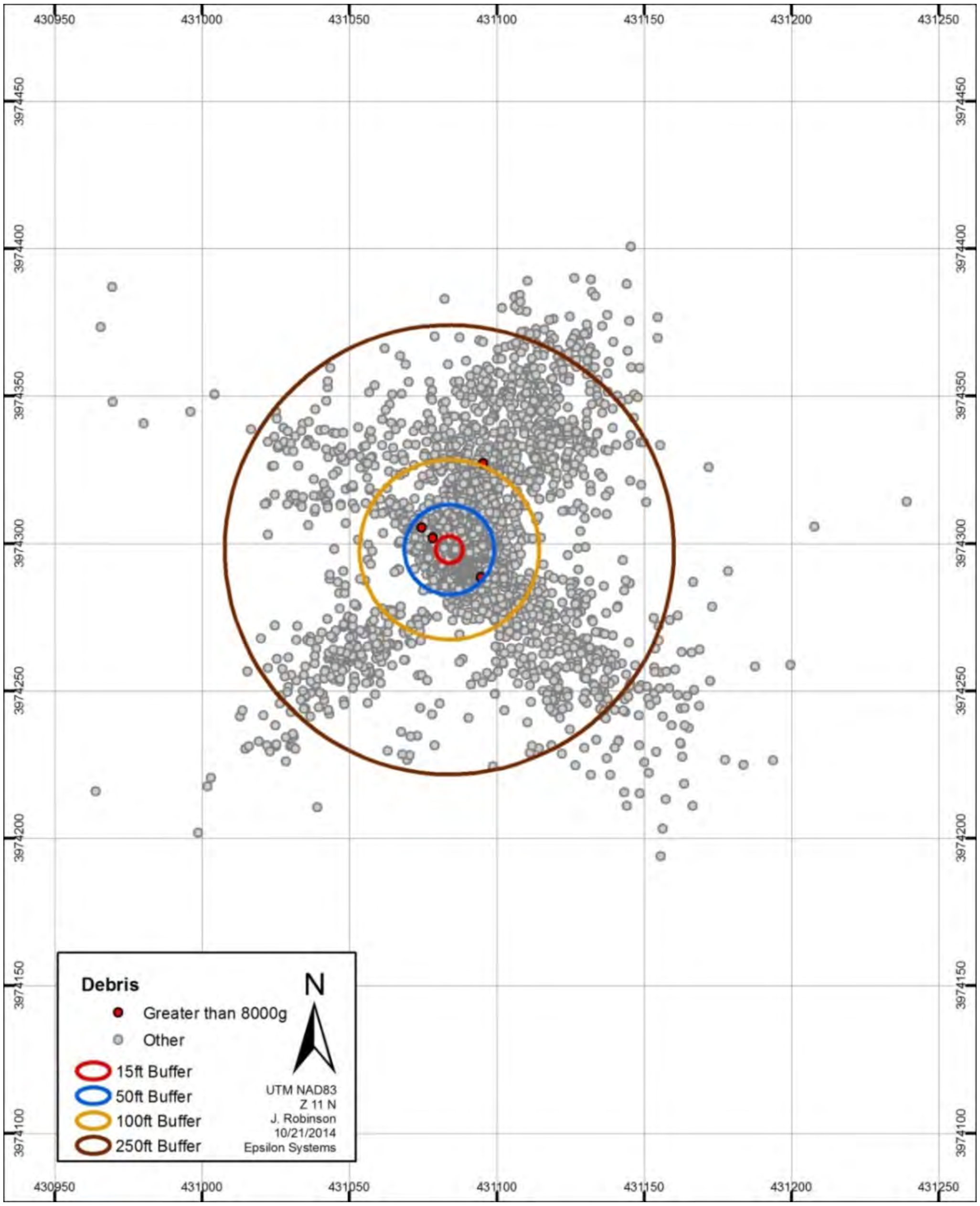

FIGURE V-41. Fragment Map of Fragments Having Weight Greater Than 8,000 Grams (Test 4).

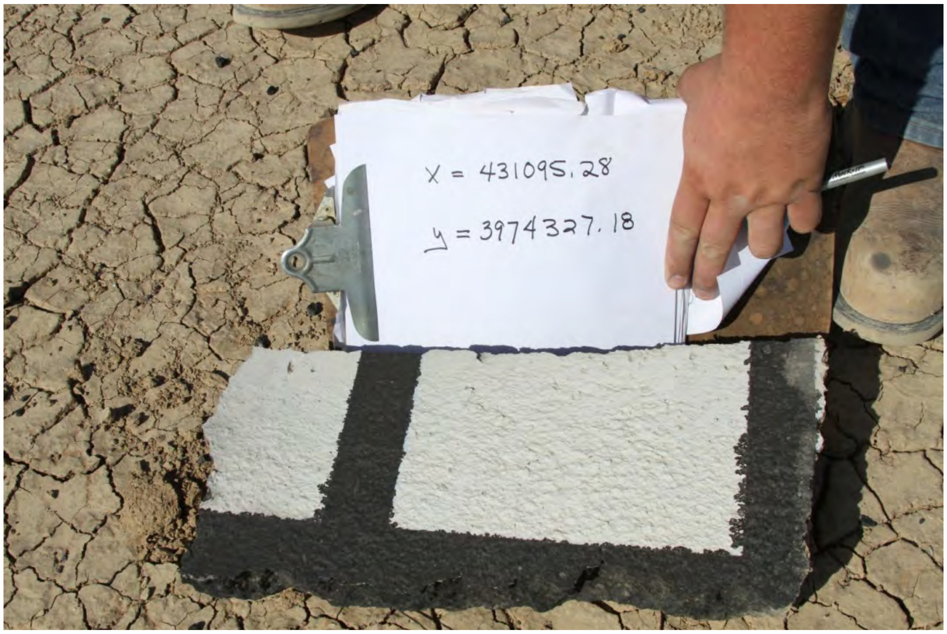

FIGURE V-42. Fragment From Roof Weighing 11,555 Grams
Found 31.5 Meters (103 Feet) From Center
of Original Structure (FCOS) (Test 4).

FIGURE V-43. Fragment From Roof Weighing 8,790 Grams
Found 22.2 Meters (72.8 Feet) FCOS (Test 4).

FIGURE V-44. Fragment From Front Wall Weighing 8,750 Grams
and Found 17.5 Meters (57.4 Feet) FCOS (Test 4).

FIGURE V-45. Roof Fragment Weighing 8,740 Grams
Found 14.25 Meters (46.8 Feet) FCOS (Test 4).

Several fragments showed the impression of the rebar and ribs as was discussed in Chapter III, Test 2. The impression of the ribs (Figure V-46) indicates that the concrete ruptured from around the rebar exposing the impression of rebar and ribs as opposed to the rebar being pulled through the concrete that would have resulted in destroying the impression of the ribs.

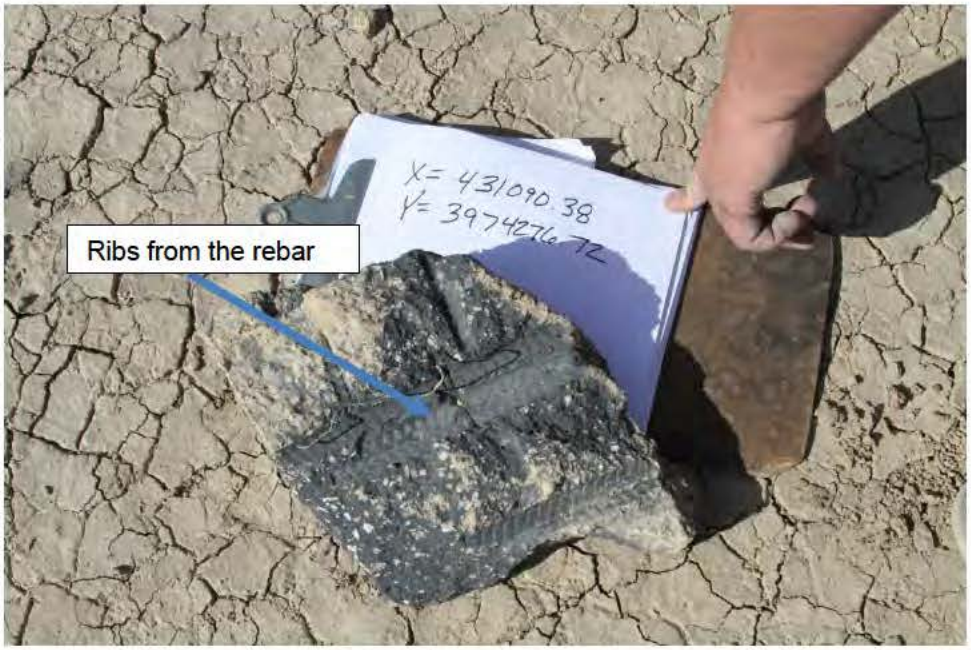

FIGURE V-46. Roof Fragment Weighing 6,375 Grams
Found 22.2 Meters (72.8 Feet) FCOS (Test 4).

Figure V-47 presents the fragment map showing the single fragment in the 5,000- to 5,999-gram range. The fragment weighed 5,245 grams, was from the roof, and was found 36.9 meters (121 feet) from the center of the structure.

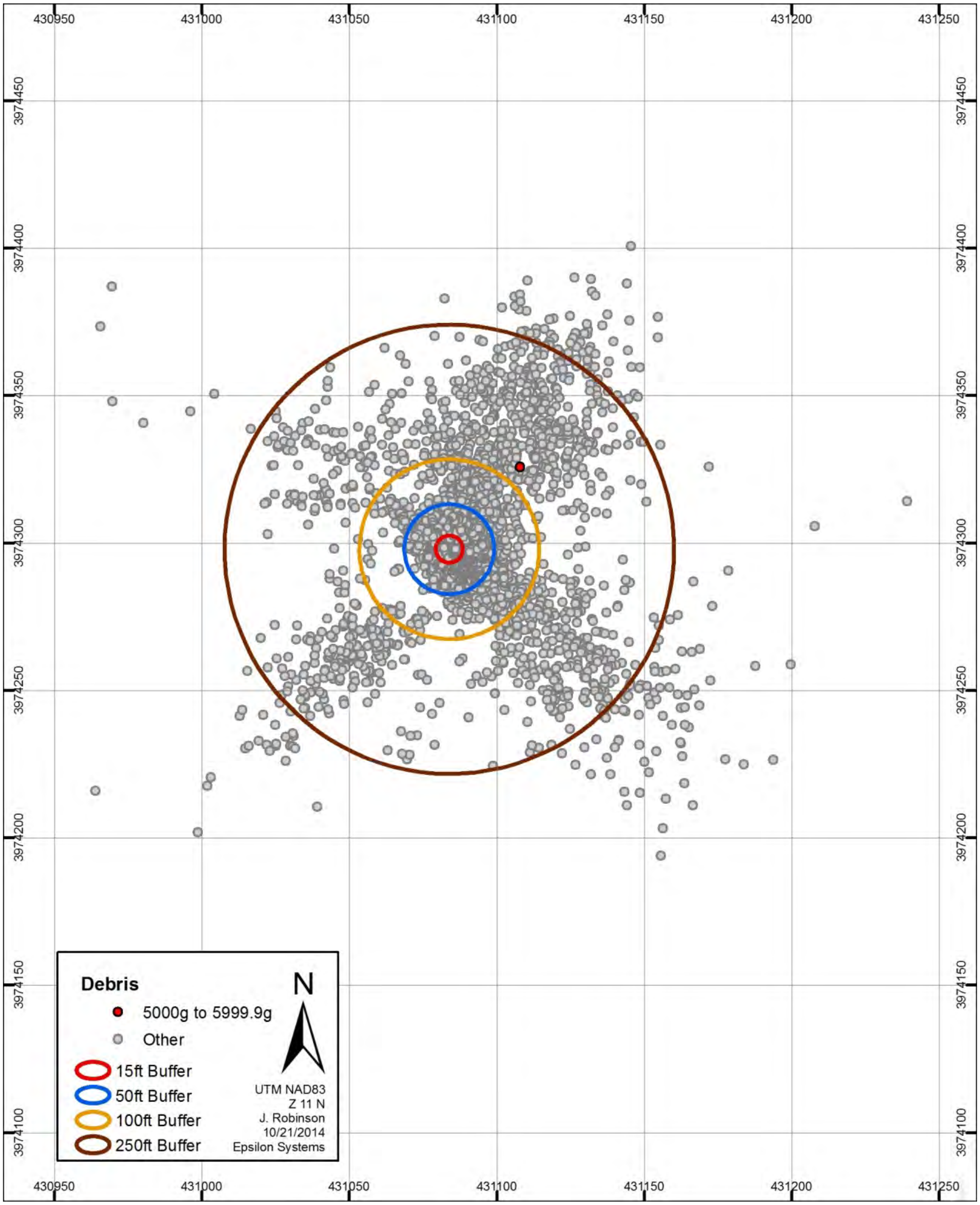

FIGURE V-47. Fragment Map Showing the Location of 5,245-Gram Fragment Found 36.9 Meters (121 Feet) FCOS (Test 4).

Figure V-48 presents the fragment map for fragments weighing between 4,000 and 4,999.9 grams. Table V-5 presents the fragment weight, origin location (e.g., roof, front wall, back wall), and distance from the center of the structure where they were found.

The motion pictures showed that some of the roof fragments essentially went straight up and then down, accounting for some of the short distances from the structure. Figure V-49 presents a photograph of the 4,535-gram roof fragment.

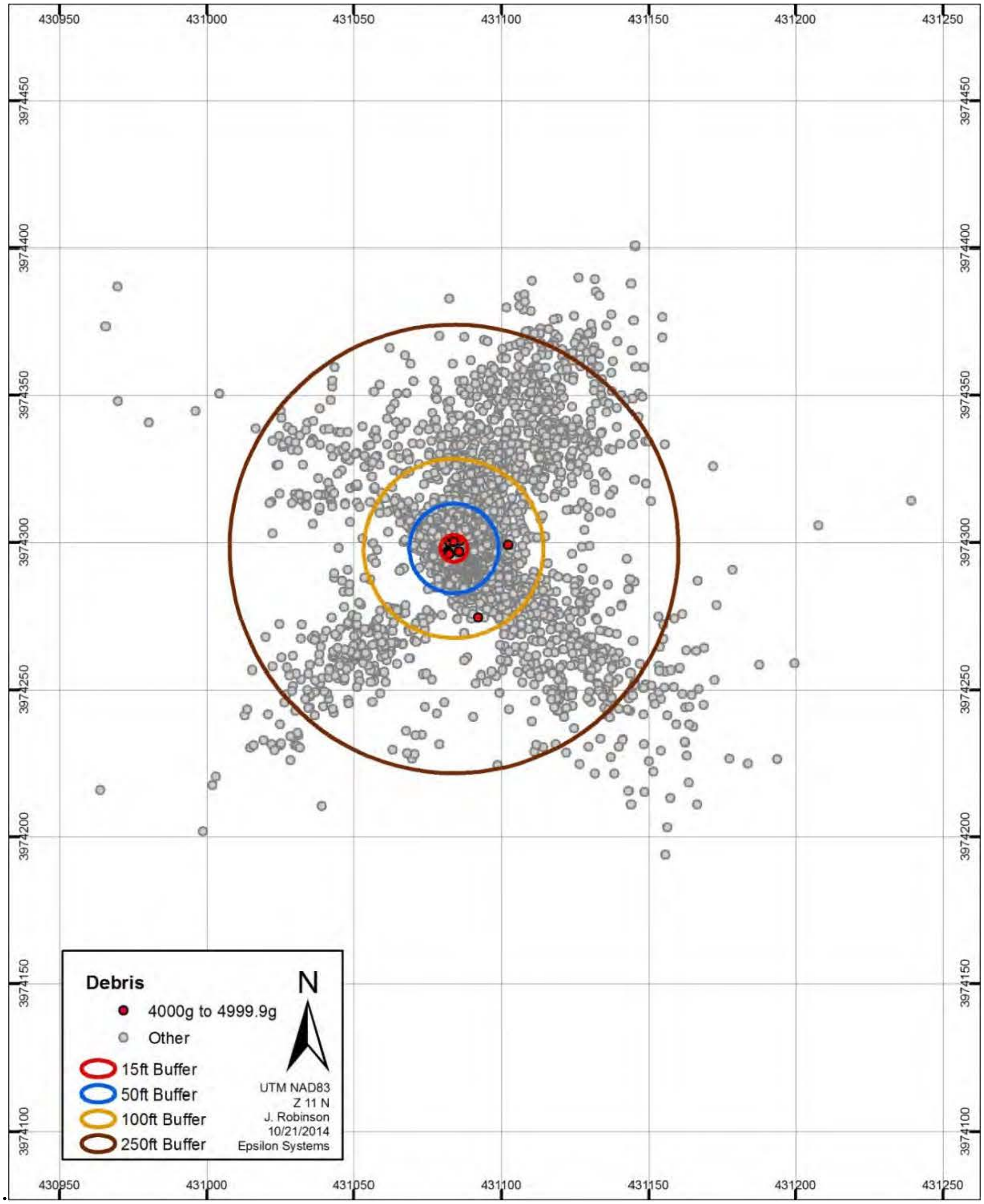

FIGURE V-48. Fragment Map of Fragments Weighing
Between 4,000 and 4,999.9 Grams (Test 4).

TABLE V-5. Fragments in 4,000- to 4,999-Gram Range (Test 4).

Fragment Weight, g	Original Location	Distance From Center of Structure Where Found, m
4,920	Front wall	3.4 (11.2 ft)
4,910	Front wall	2.4 (7.9 ft)
4,735	Back wall	2.4 (7.9 ft)
4,600	Front wall	2.4 (7.9 ft)
4,555	Roof	1.7 (5.6 ft)
4,535*	Roof	25 (82 ft)
4,390	Roof	18.5 (60.7 ft)
4,390	Front wall	3.5 (11.5 ft)
4,375	Roof	2.5 (8.2 ft)
4,310	Back wall	2.4 (7.9 ft)

*Beyond IBD.

FIGURE V-49. Roof Fragment Weighing 4,535 Grams Found
25 Meters (82 Feet) FCOS (Test 4).

Figure V-50 presents the fragment map for fragments in the 3,000- to 3999.9-gram range. There were 28 fragments in this range with all but six being fragments from the roof. Four of the fragments were from the front wall, and two were from the back wall. Five of the fragments landed at or just beyond the calculated IBD (23 meters or 75 feet). Figure V-51 represents one of the roof fragments weighing 3,905 grams and found at distance of 22 meters (72.2 feet).

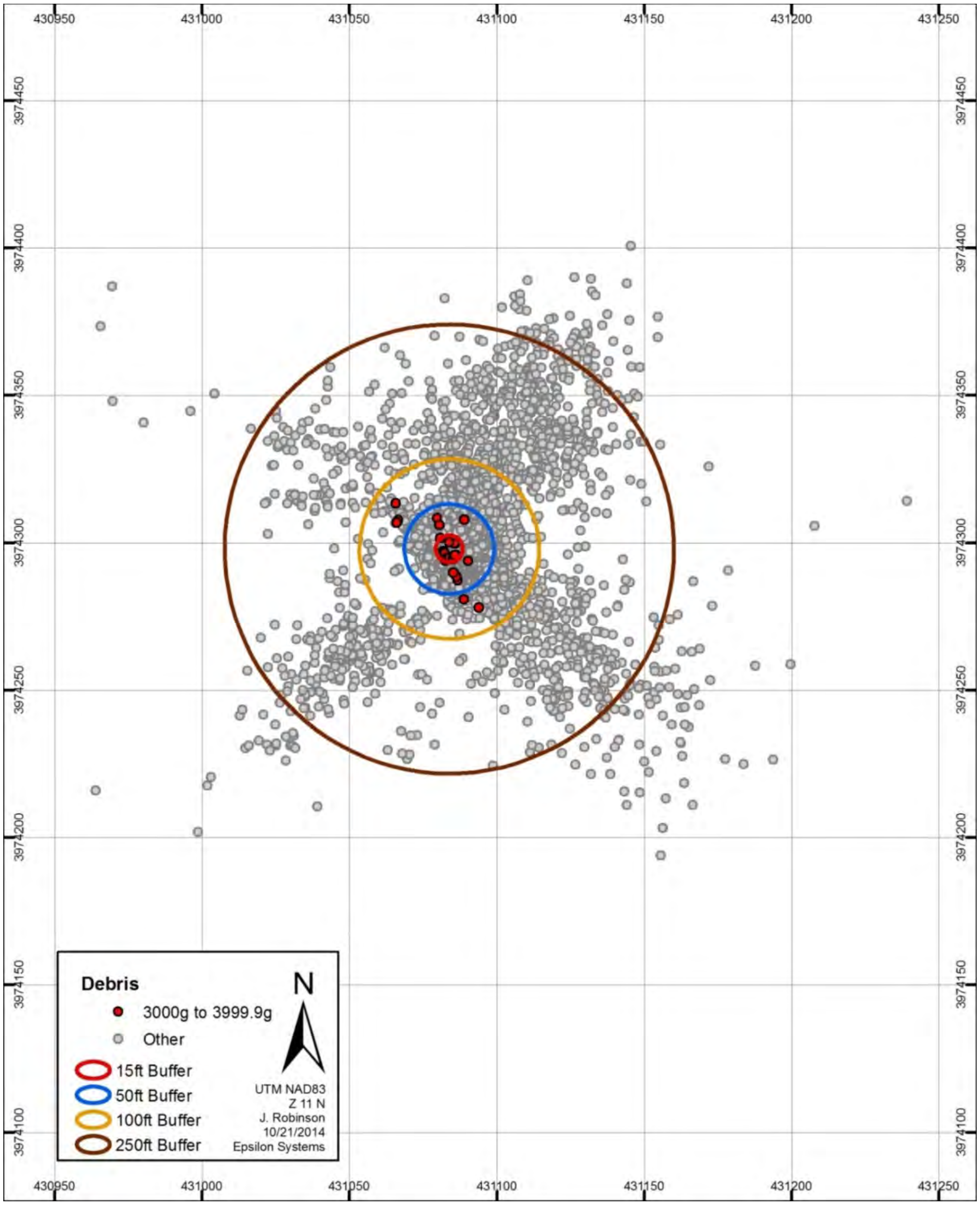

FIGURE V-50. Fragment Map of Fragments in the
3,000- to 3,999.9-Gram Weight Range (Test 4).

FIGURE V-51. Roof Fragment Weighing 3,905 Grams
Found 22 Meters (72.2 Feet) FCOS (Test 4).

Figure V-52 presents the fragment map for the fragments in the 2,000- to 2,999.9-gram range. There are 37 items in this range including some bare rebar fragments. Six of the fragments were found beyond the calculated IBD.

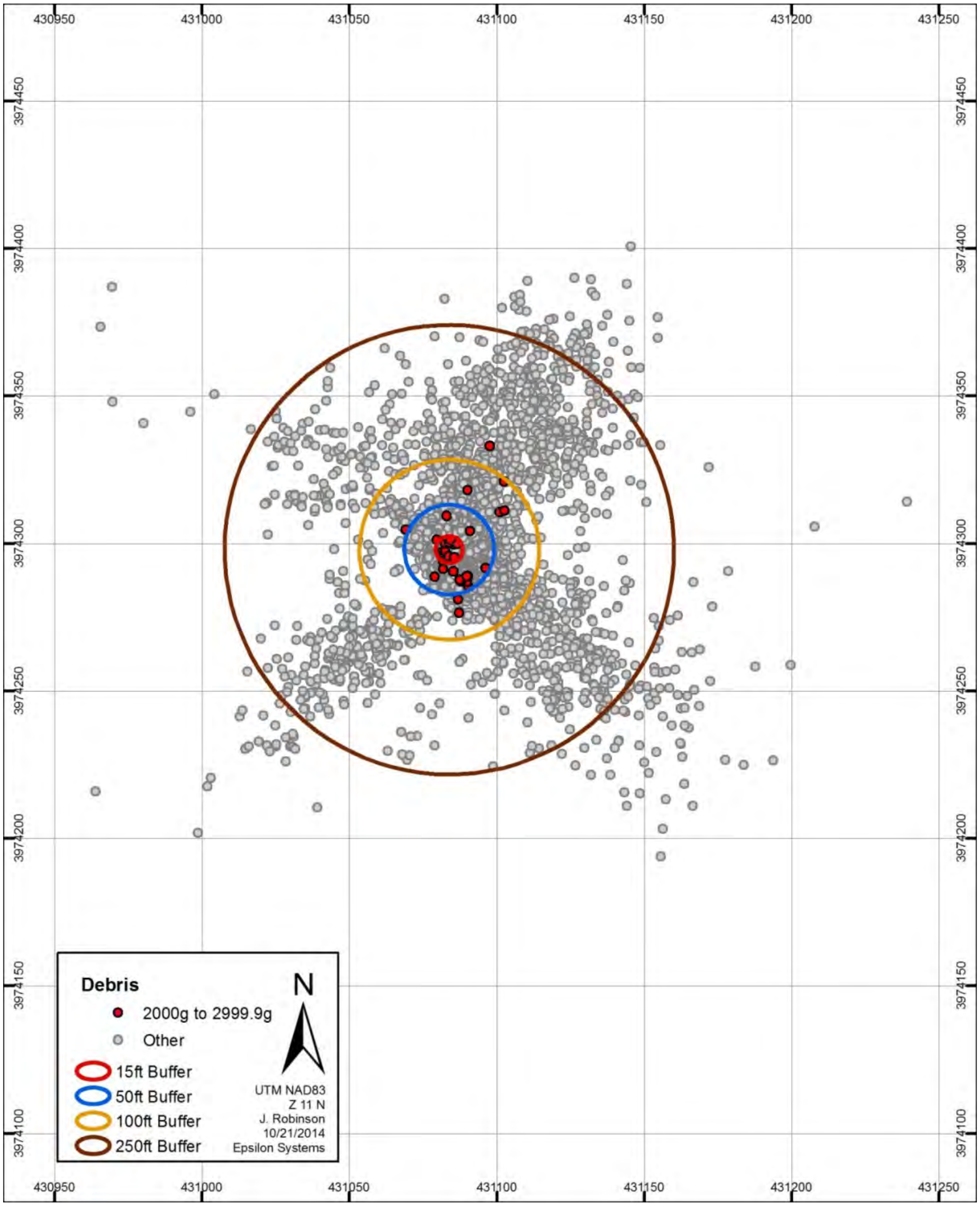

FIGURE V-52. Fragment Map of 2,000- to 2,999.9-Gram Weight Range (Test 4).

Figure V-53 presents the fragment map for the 31 fragments having weight between 1,000 and 1,999.9 grams. Twenty-five of the 31 fragments were from the roof, 5 from the front wall, and 1 from the back wall. The fragment from the back wall, shown in Figure V-54, weighed 1,167.5 grams and was found in the southwest direction at 90.7 meters (297.6 feet) from the center of the structure. A roof fragment was found in the northeast direction (shown in Figure V-55) weighing 1,029.7 grams at 84.9 meters (278.6 feet) from the center of the structure.

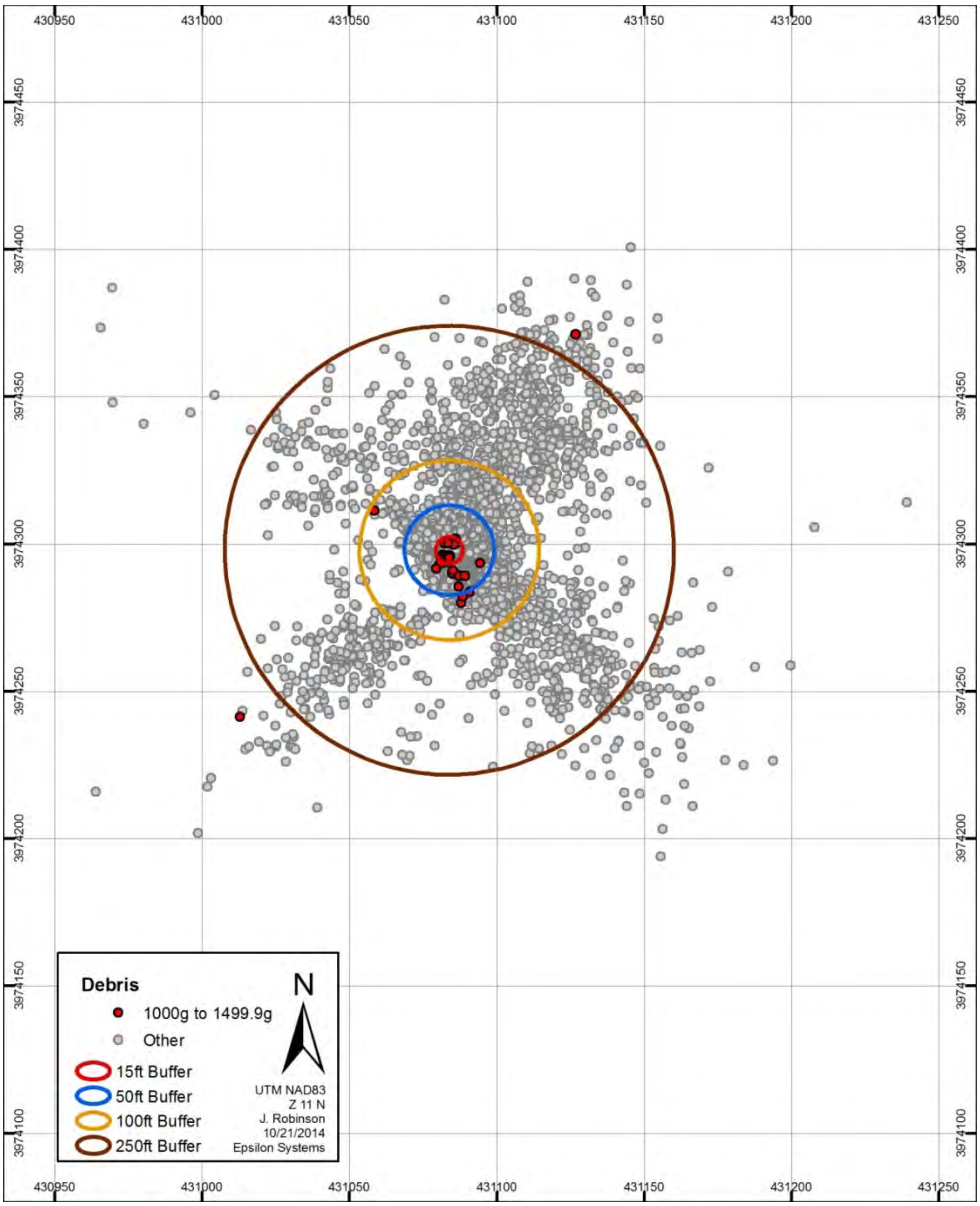

FIGURE V-53. Fragment Map of Fragments in 1,000- to 1,499.9-Gram Range (Test 4).

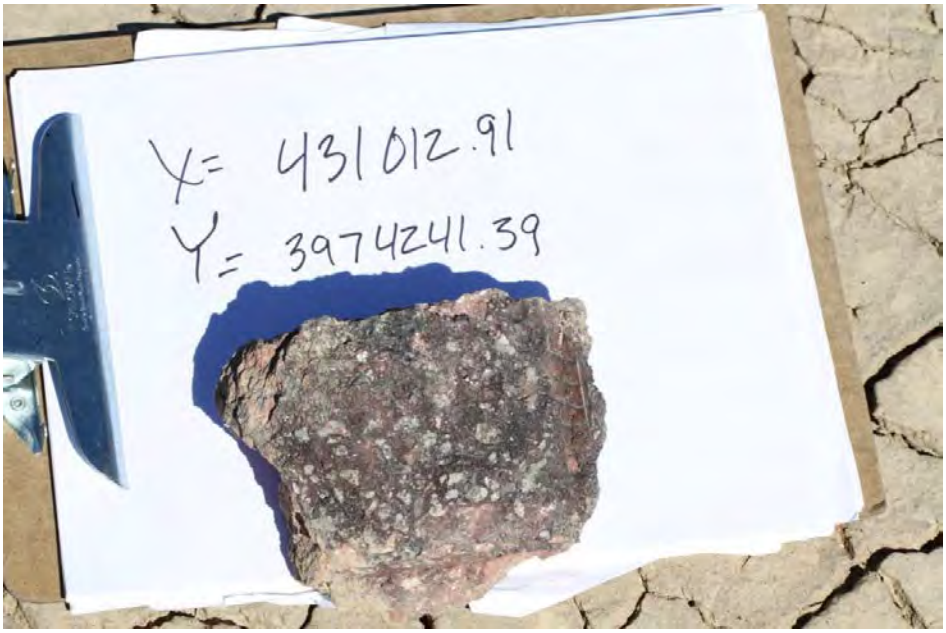

FIGURE V-54. Fragment From Back Wall Weighing 1,167.5 Grams Found 90.7 Meters (297.6 Feet) FCOS in Southwest Direction (Test 4).

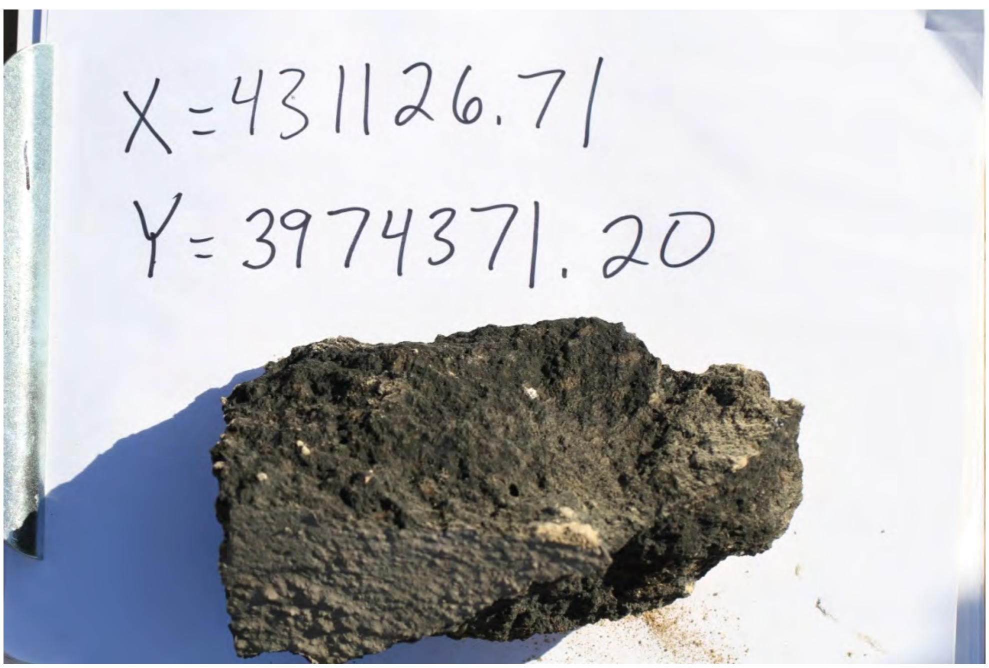

FIGURE V-55. Roof Fragment Weighing 1,029.7 Grams Found 84.9 Meters (278.6 feet) Northeast FCOS (Test 4).

There were a total of 3,245 fragments recovered in Test 4; 1,419 of those fragments were found beyond the calculated IBD (23 meters or 75 feet). As was mentioned earlier, all of the fragment maps for the various weight groups along with photographs of significant fragments are presented in Appendix V-G.

CONCLUSIONS AND RECOMMENDATIONS—TEST 4

Test 4 experienced choked flow, as indicated by the internal pressure, that resulted in rupture of the structure. The rupture occurred at 2.3 seconds after ignition of the M1 propellant and at an internal pressure of 34 psi. This is in contrast to Test 2 where the rupture occurred at 1.4 seconds after ignition and at 47 psi. As discussed in Chapter I, the differences between the two tests was largely due to the grain geometries leading to differences in propellant mass burning and interior pressurization rates.

The rupture occurred quickly (seconds after ignition) and at relatively low pressures, hence not much of the propellant had been consumed at rupture. Most of the M1 propellant burned after rupture and resulted in the large fireballs outside the original structure, as seen in Figures V-22 through V-25. The Doppler radar measured the plume/fireball for 16 seconds with a maximum velocity of 245 meters per second. The large fireball was projected to the north of the original structure rising with distance from the structure. Most of the instrumentation was not engulfed in the fireball. The maximum external heat flux measured for Test 4 was 1,137.897 kW/m^2 and was measured 11 feet from the structure. Beyond the IBD (23 meters or 75 feet), the peak heat flux was 36.34 kW/m^2 at 79 feet (gage 12). The flux formulation provided by Reference V-1 estimates that an exposure time of 1.05 seconds for 36.34 kW/m^2 results in injury (second-degree burns). At 322 feet, the farthest gage location, the peak flux was measured to be 4.23 kW/m^2 allowing for 24.4 seconds of exposure prior to injury. The rupture also produced many structural debris fragments with some projected significant distance from the original structure location. Some of the debris fragments were found more than 450 feet from the center of the original structure. A total of 3,245 fragments were recovered and cataloged. Many of the fragments were quite large weighing more than 1 kg. The largest fragment produced in Test 4 was 11.55 kg. A total of 1,419 fragments were recovered beyond the calculated IBD.

The fragments produced in Test 4 came from all the walls as well as the roof of the structure, as shown in Figure V-35. Test 4 generated fragments from all four walls and the roof unlike Test 2 where the fragments originated from the roof and front (north) wall.

The wall fragments in Test 4 were found at significant distances from the original structure location. Doppler radar detected a maximum fragment velocity of 130 m/s.

Some of the Test 4 fragment weights and locations are summarized in the following:

- A fragment from the west wall weighed 434 grams and was found 140.3 meters (460 feet) FCOS.
- A fragment from the rear (south) wall weighed 361.5 grams and was found 145.2 meters (476 feet) FCOS.
- A fragment from the east wall weighed 128.2 grams and was found 126.2 meters (414 feet) FCOS.
- A fragment from the front (north) wall weighed 23.7 grams and was found 156.1 meters (512 feet) FCOS.

The largest debris fragment generated in Test 4 came from the roof. Many of the fragments and thermal hazards in Test 4 exceeded the IBD/PTRD and IMD distances calculated for 1,108 pounds of 1.3 material. Test 2 also resulted in similar fragment and thermal hazards beyond the calculated the IBD/PTRD and IMD as called out in DOD-M 6055.09 (Reference V-2).

After reviewing the results of this test as well as the results of Tests 1 through 3 of this series, it has been recommended that further investigation should be performed on the effects of reinforcing the structure at the wall interfaces and the door. It is also recommended that more quantitative data be collected about the plume and fireball. This should include length and flux within and around the plume and fireball.

REFERENCES

V-1. Society of Fire Prevention Engineers. *Engineering Guide Predicting 1st and 2nd Degree Skin Burns from Thermal Radiation*. Bethesda, MD, Society of Fire Prevention Engineers, March 2009.

V-2. Office of the Deputy Under Secretary of Defense (Installations and Environment). *DOD Ammunition and Explosives Safety Standards.* Washington, D.C., USD(I&E), 29 February 2008. Administratively Reissued 4 August 2010. (DODM 6055.09-M, Volume 1, Enclosures 8 and 9; publication UNCLASSIFIED.)

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Appendix V-A

HD 1.3 TEST 4. PRESSURE DATA

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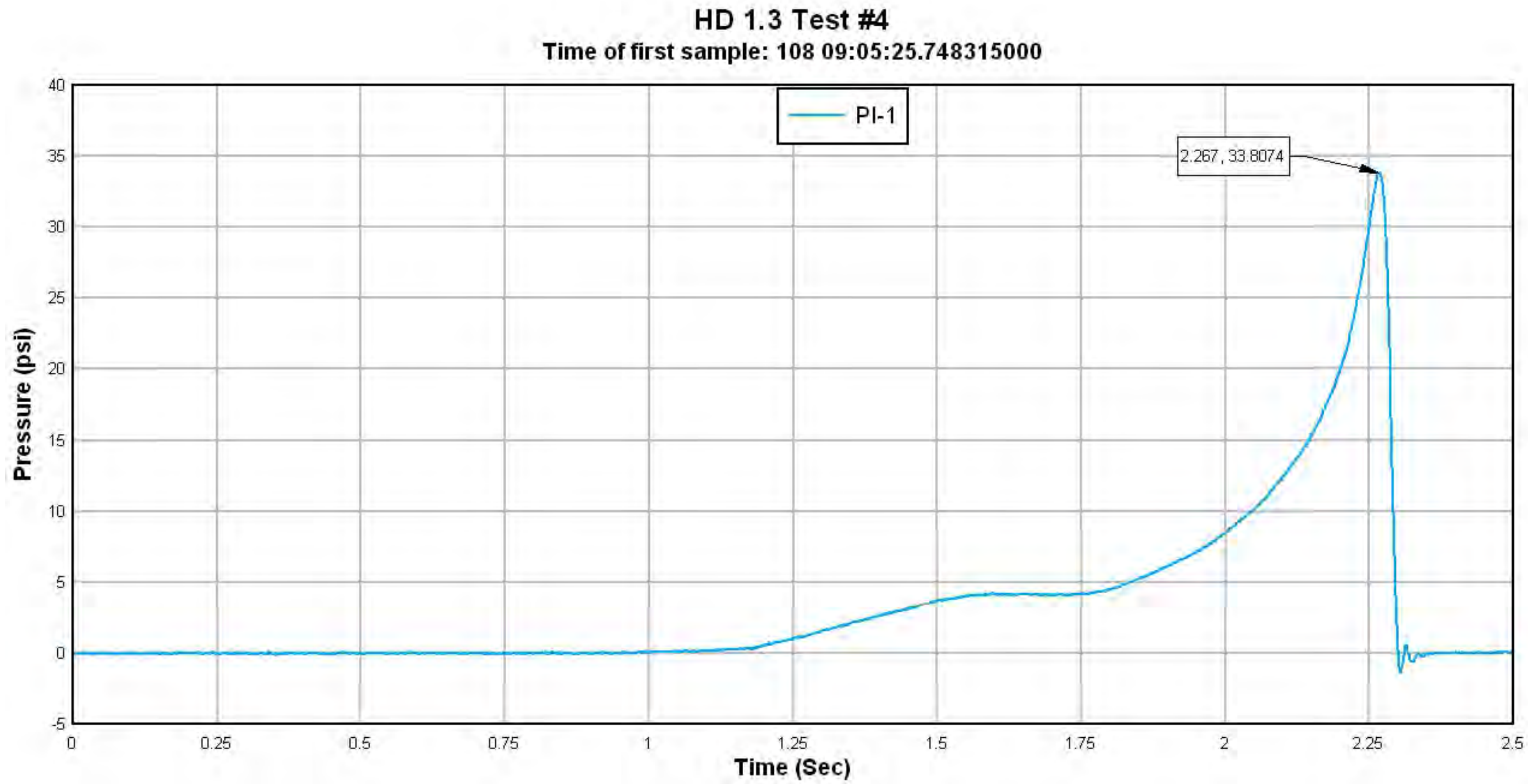


FIGURE V-A-1. Internal Pressure Gage #1.

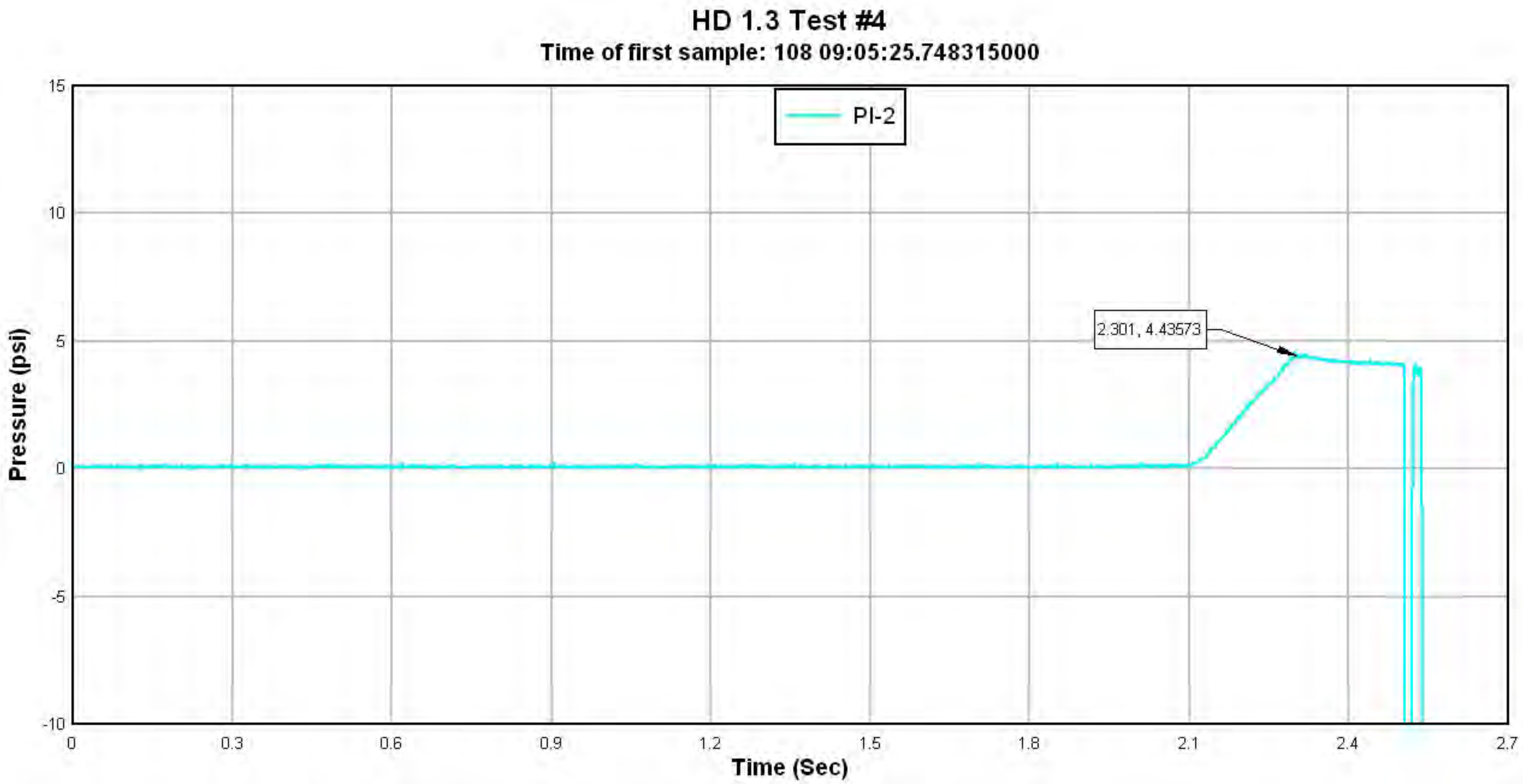


FIGURE V-A-2. Internal Pressure Gage #2.

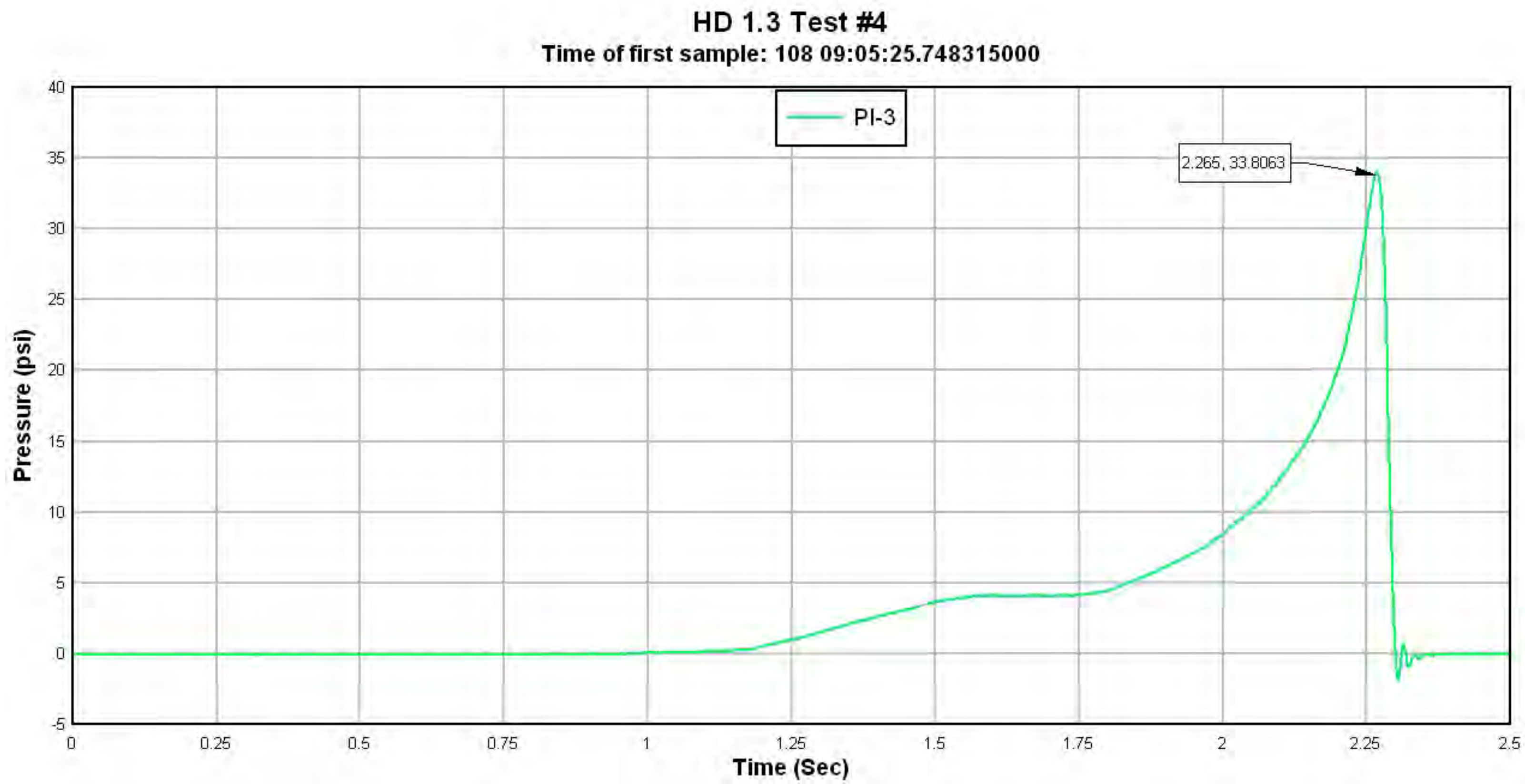


FIGURE V-A-3. Internal Pressure Gage #3.

FIGURE V-A-4. Internal Pressure Gage #4.

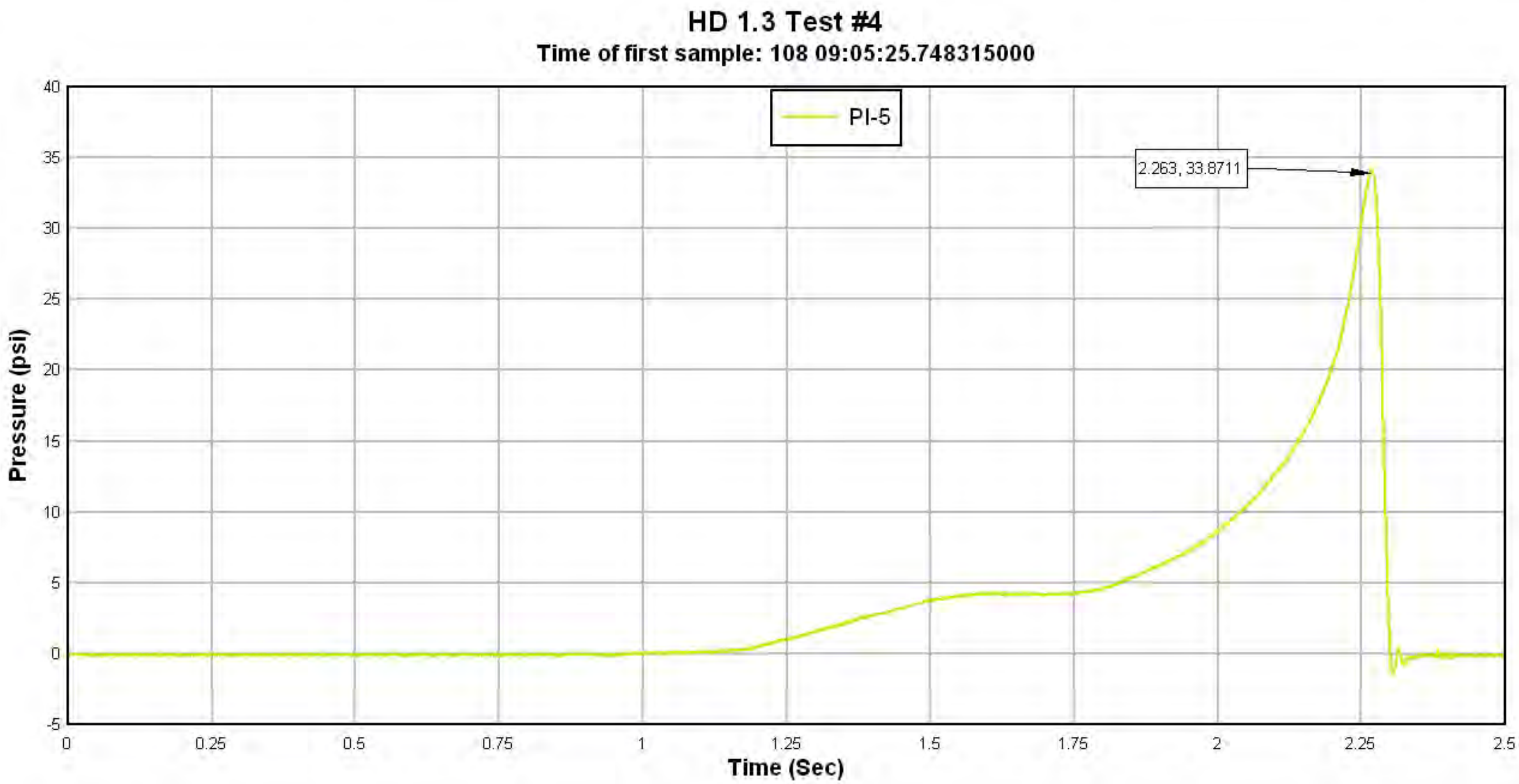


FIGURE V-A-5. Internal Pressure Gage #5.

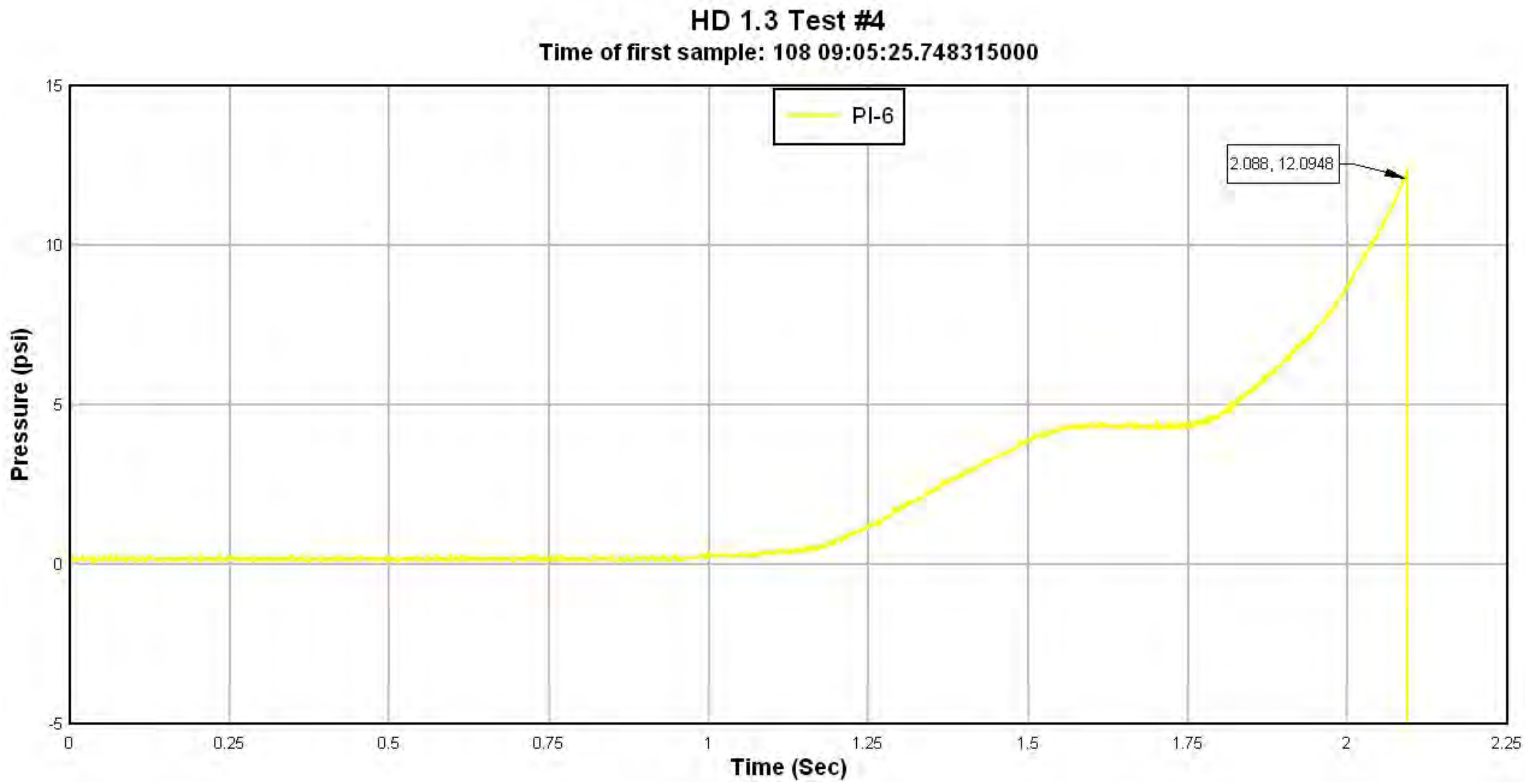


FIGURE V-A-6. Internal Pressure Gage #6.

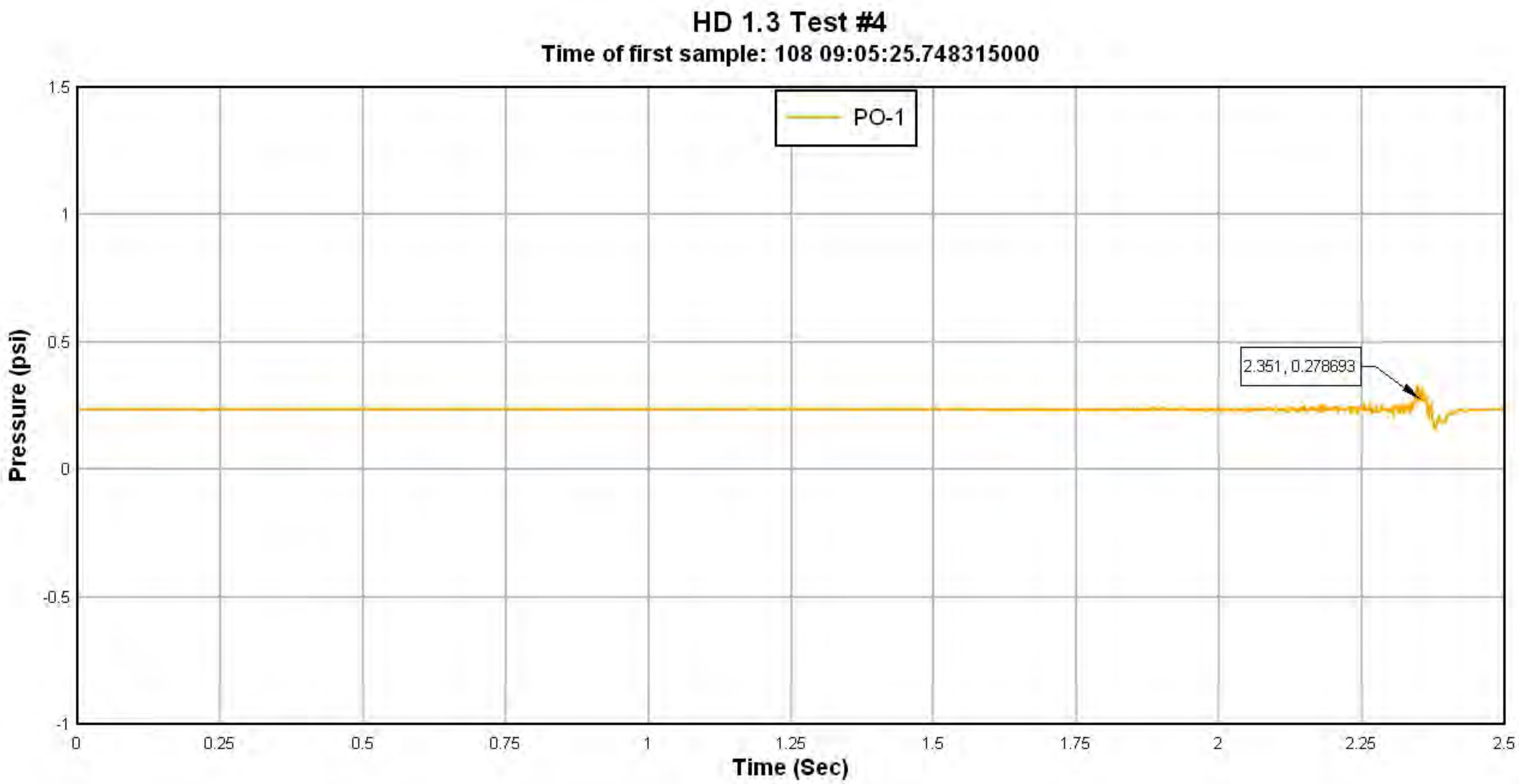


FIGURE V-A-7. External Pressure Gage #1.

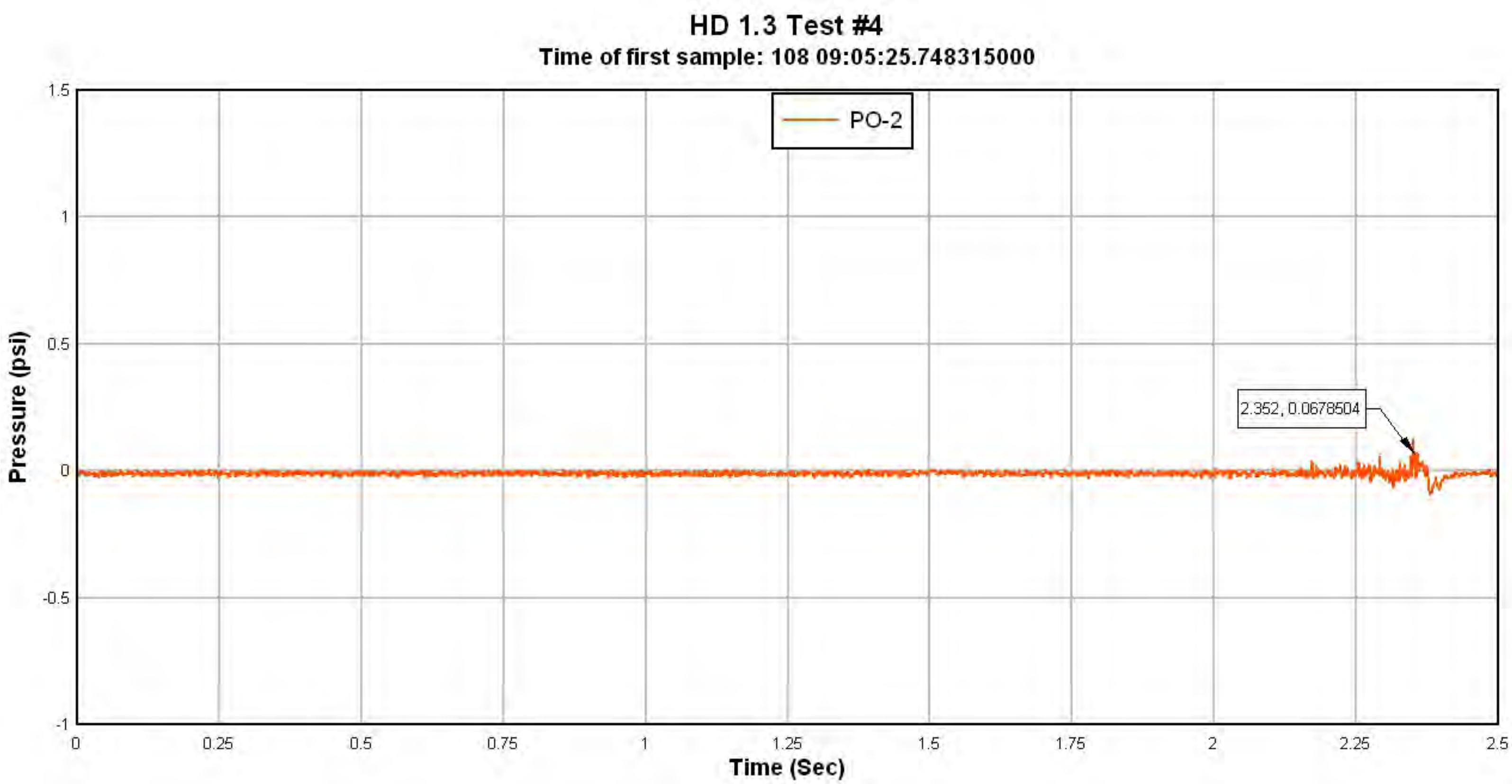


FIGURE V-A-8. External Pressure Gage #2.

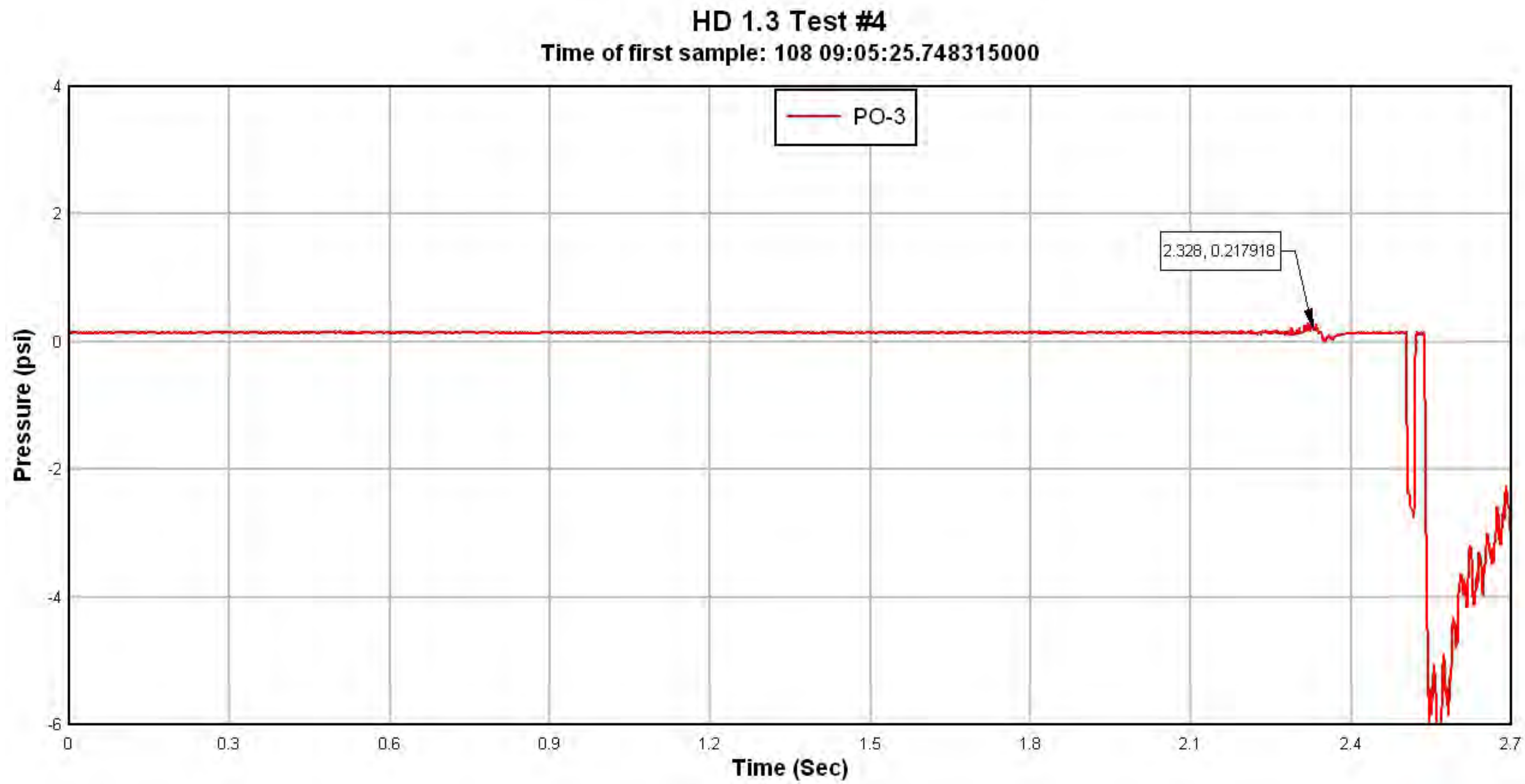


FIGURE V-A-9. External Pressure Gage #3.

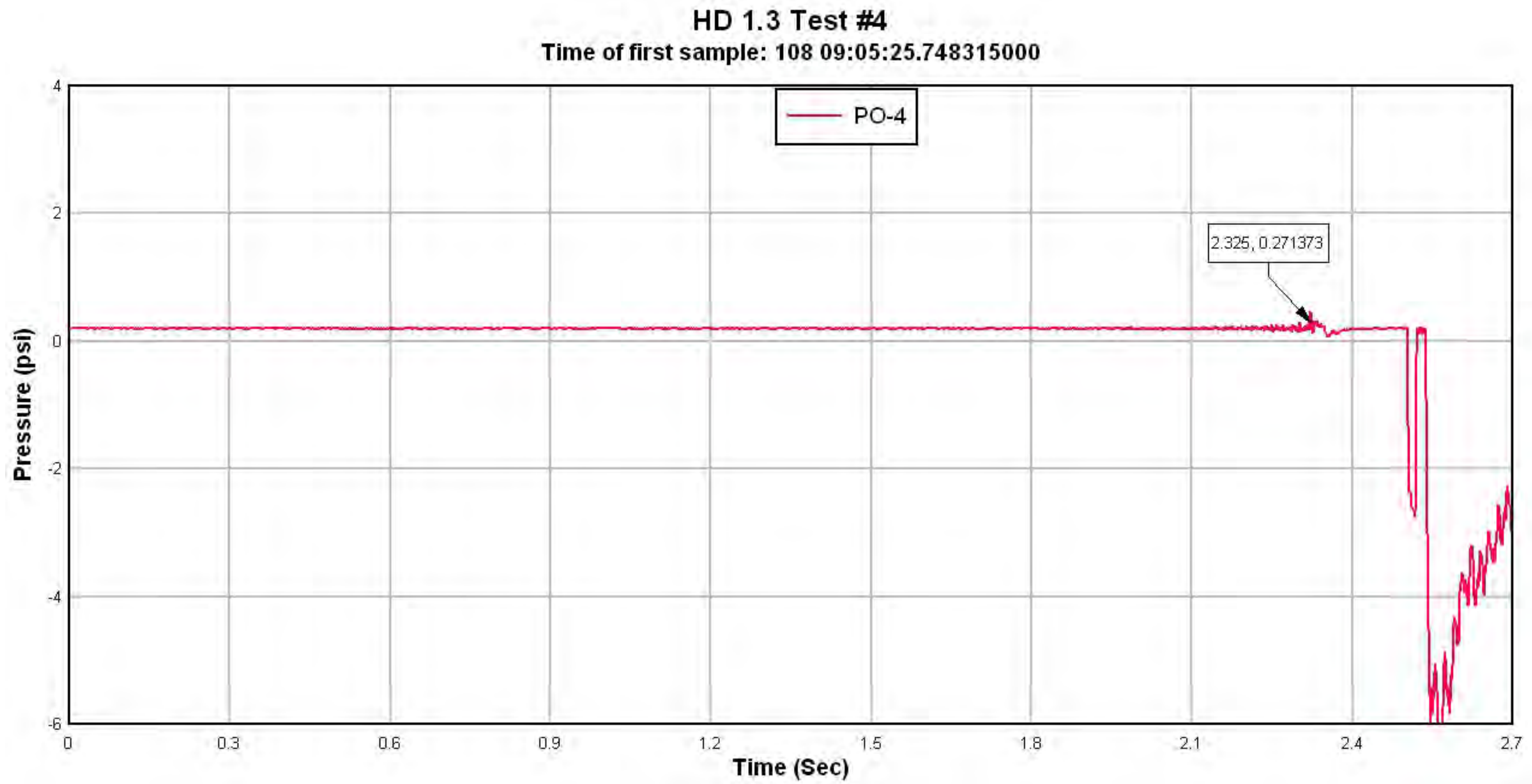


FIGURE V-A-10. External Pressure Gage #4.

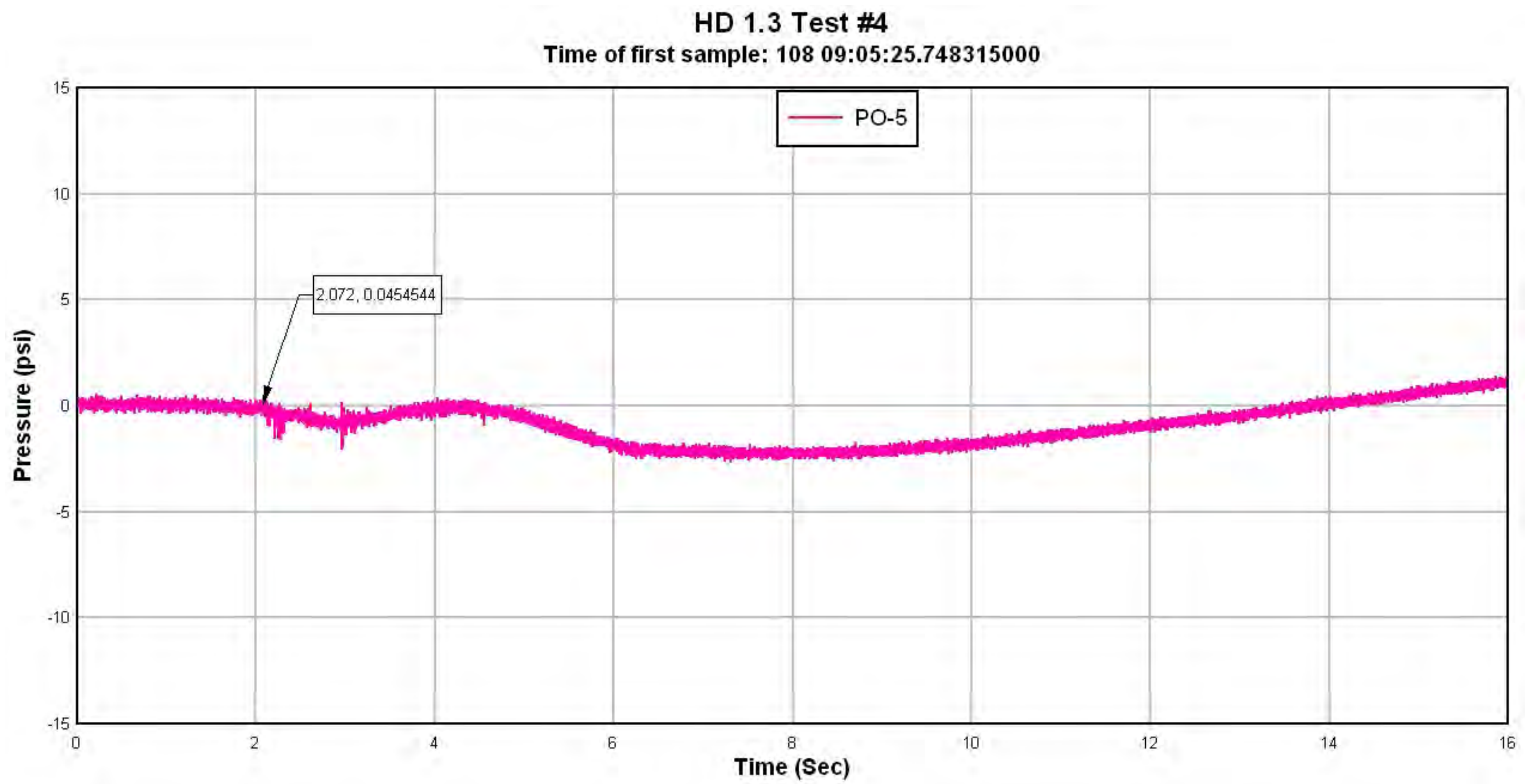


FIGURE V-A-11. External Pressure Gage #5.

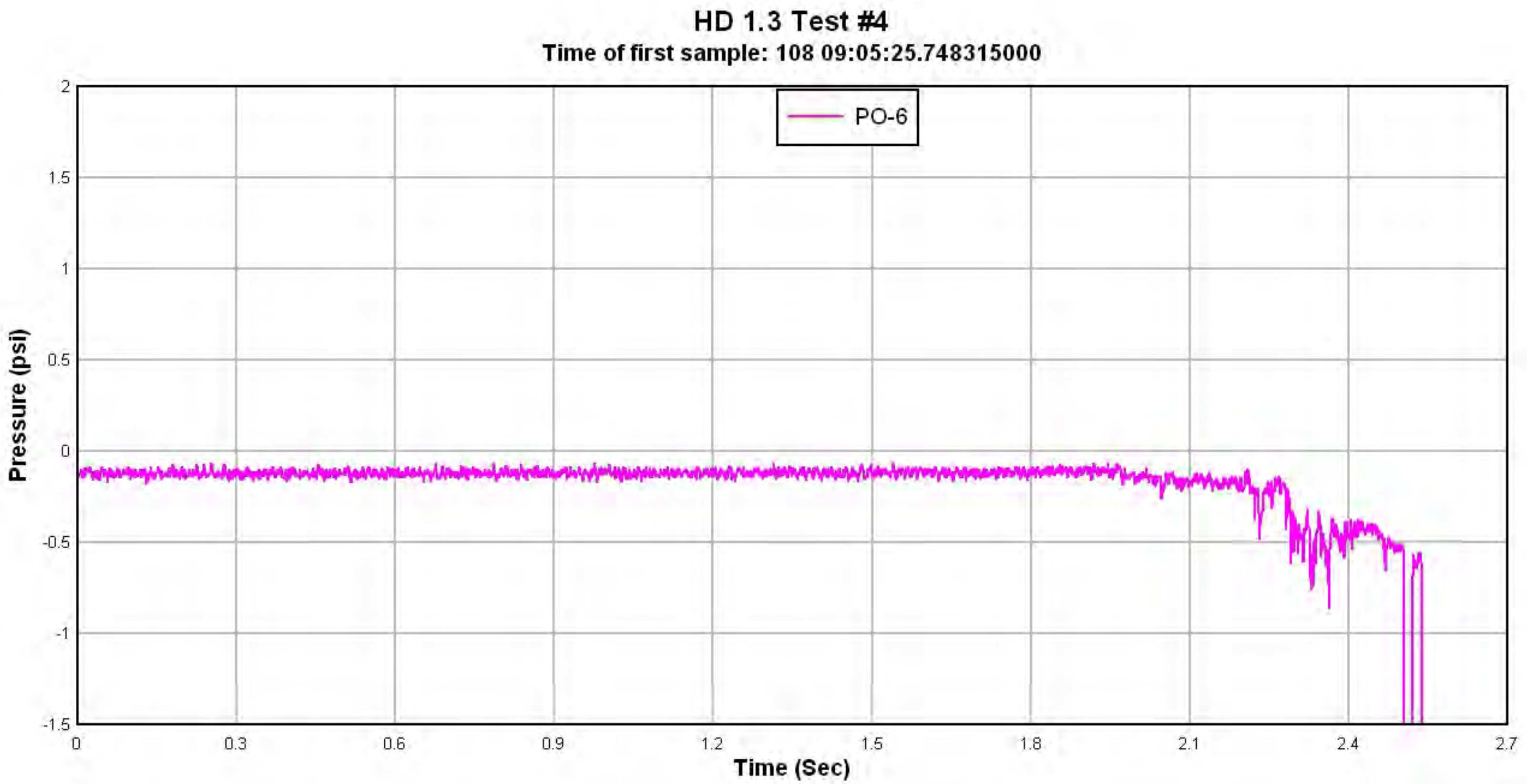


FIGURE V-A-12. External Pressure Gage #6.

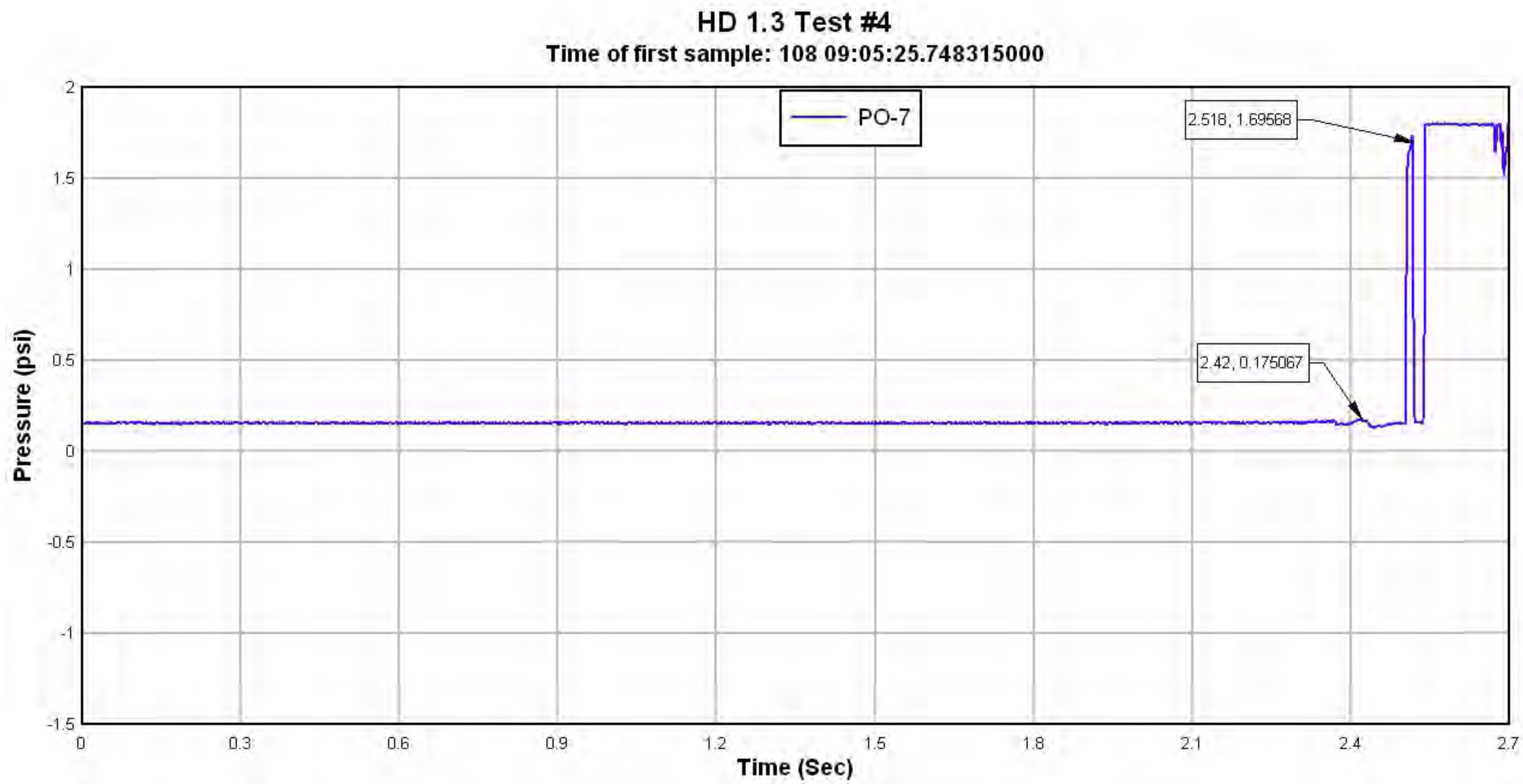


FIGURE V-A-13. External Pressure Gage #7.

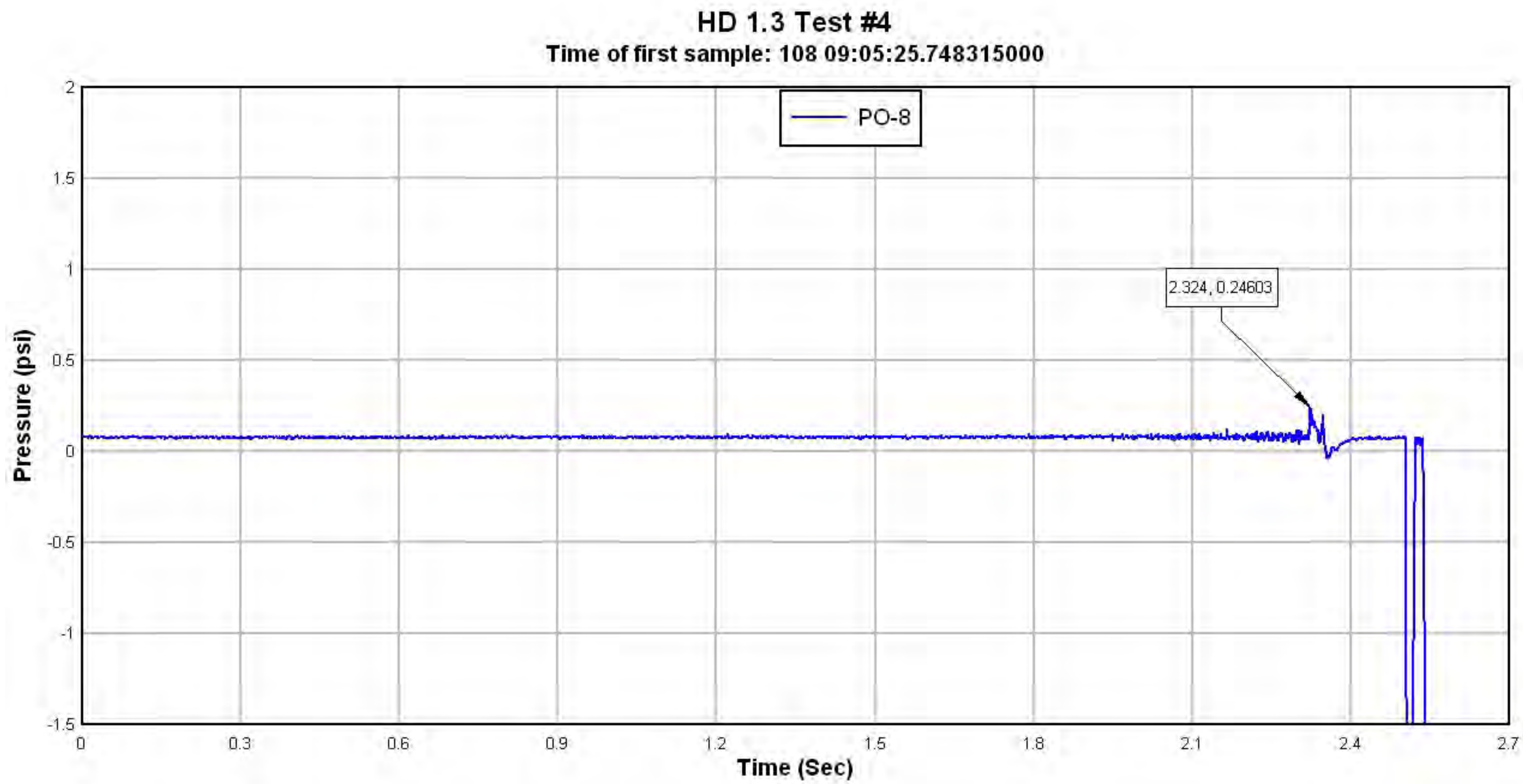
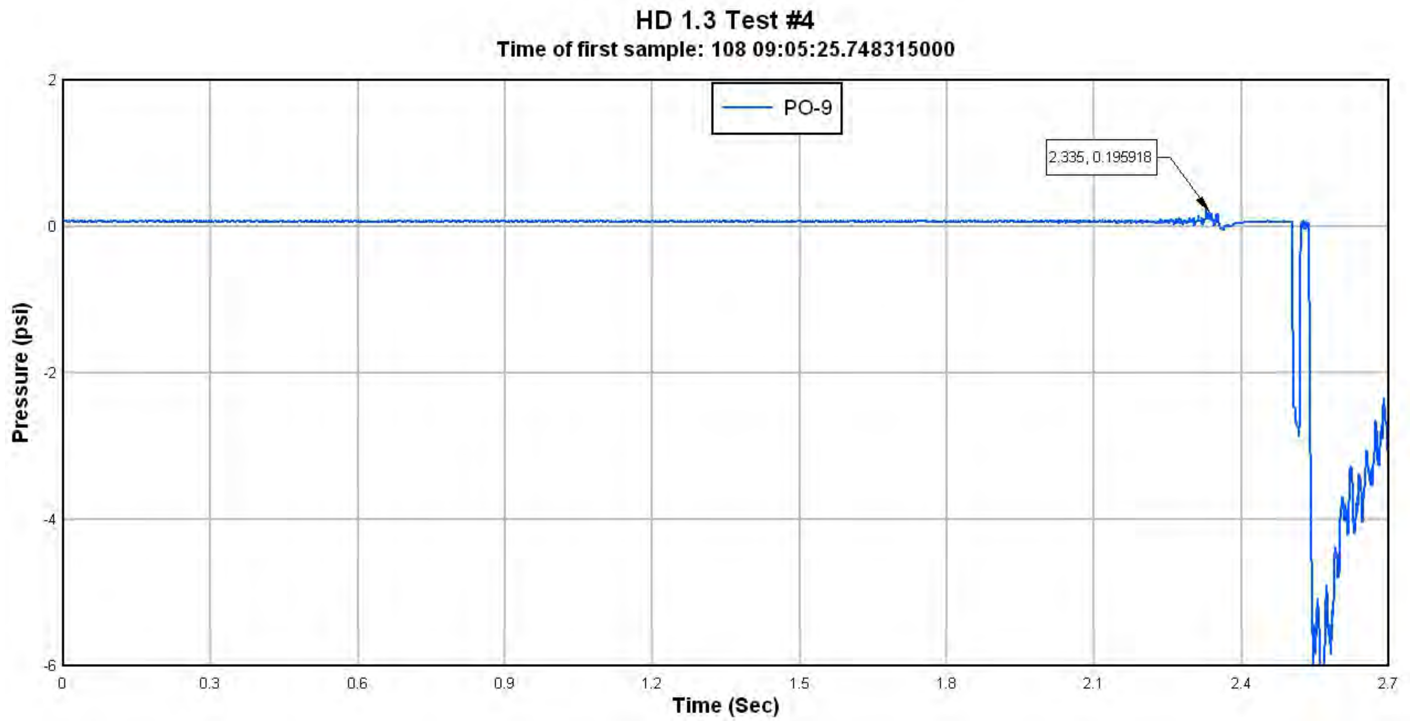


FIGURE V-A-14. External Pressure Gage #8.

External Pressure Gage #9



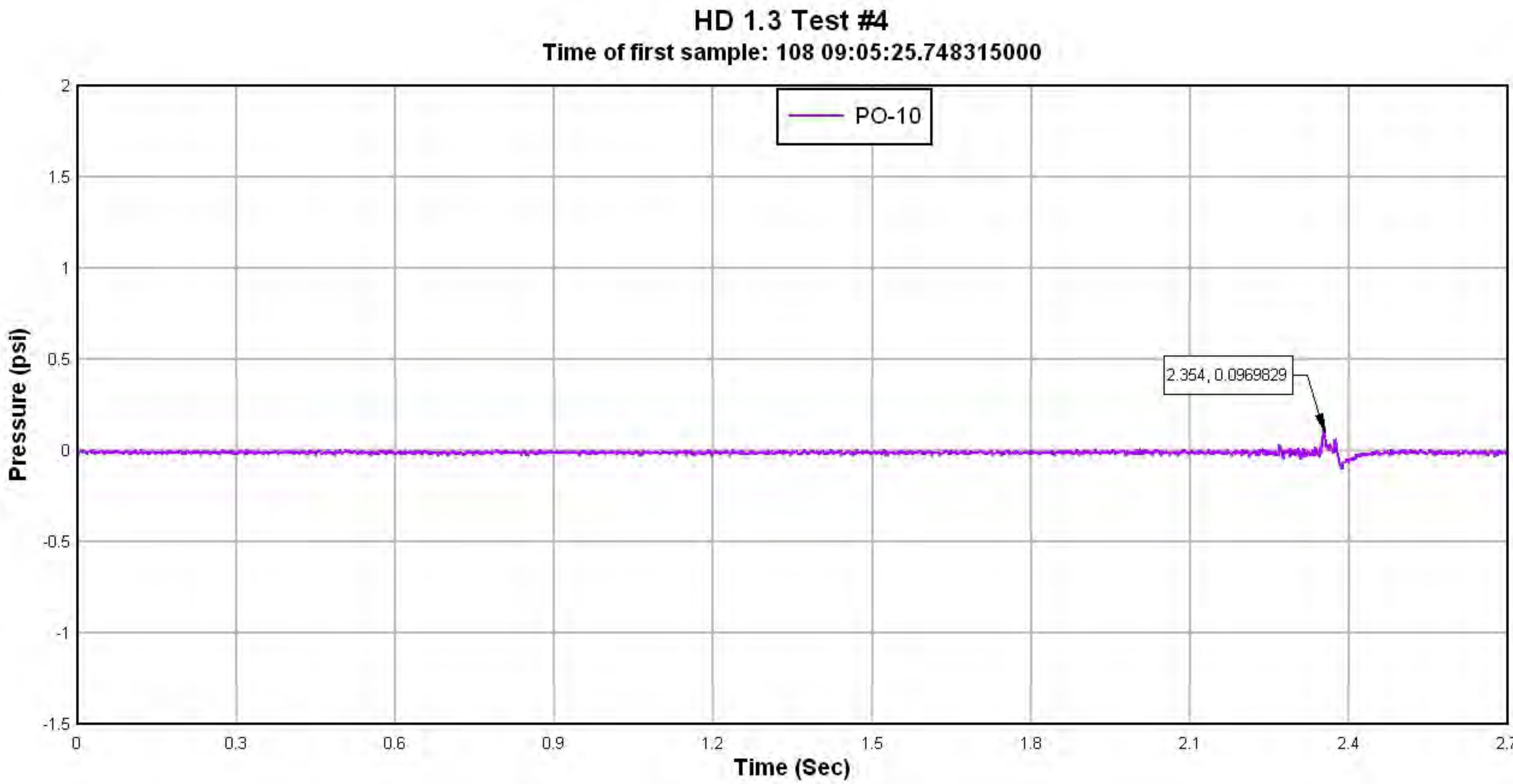


FIGURE V-A-15. External Pressure Gage #10.

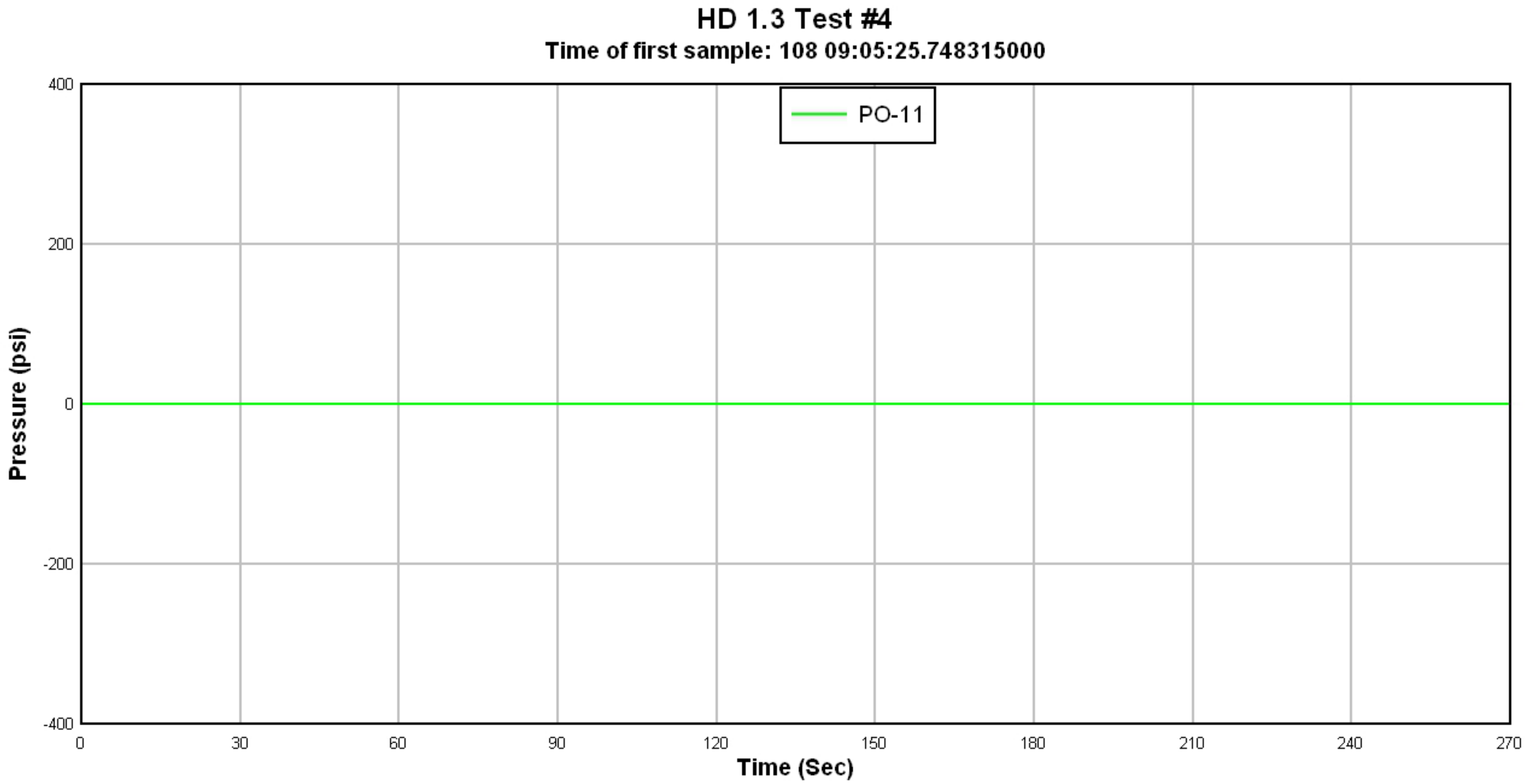


FIGURE V-A-16. External Pressure Gage #11.

Summary

- Peak Internal Pressure 33.87 psi at Gage 5 at 2.26 sec

- Peak External Pressure
  – 1.70 psi at gage 7 at 2.51 seconds
  – 0.278 psi gage 1 at 2.35 seconds

Appendix V-B

HD 1.3 TEST 4. TEMPERATURE AND THERMAL FLUX DATA

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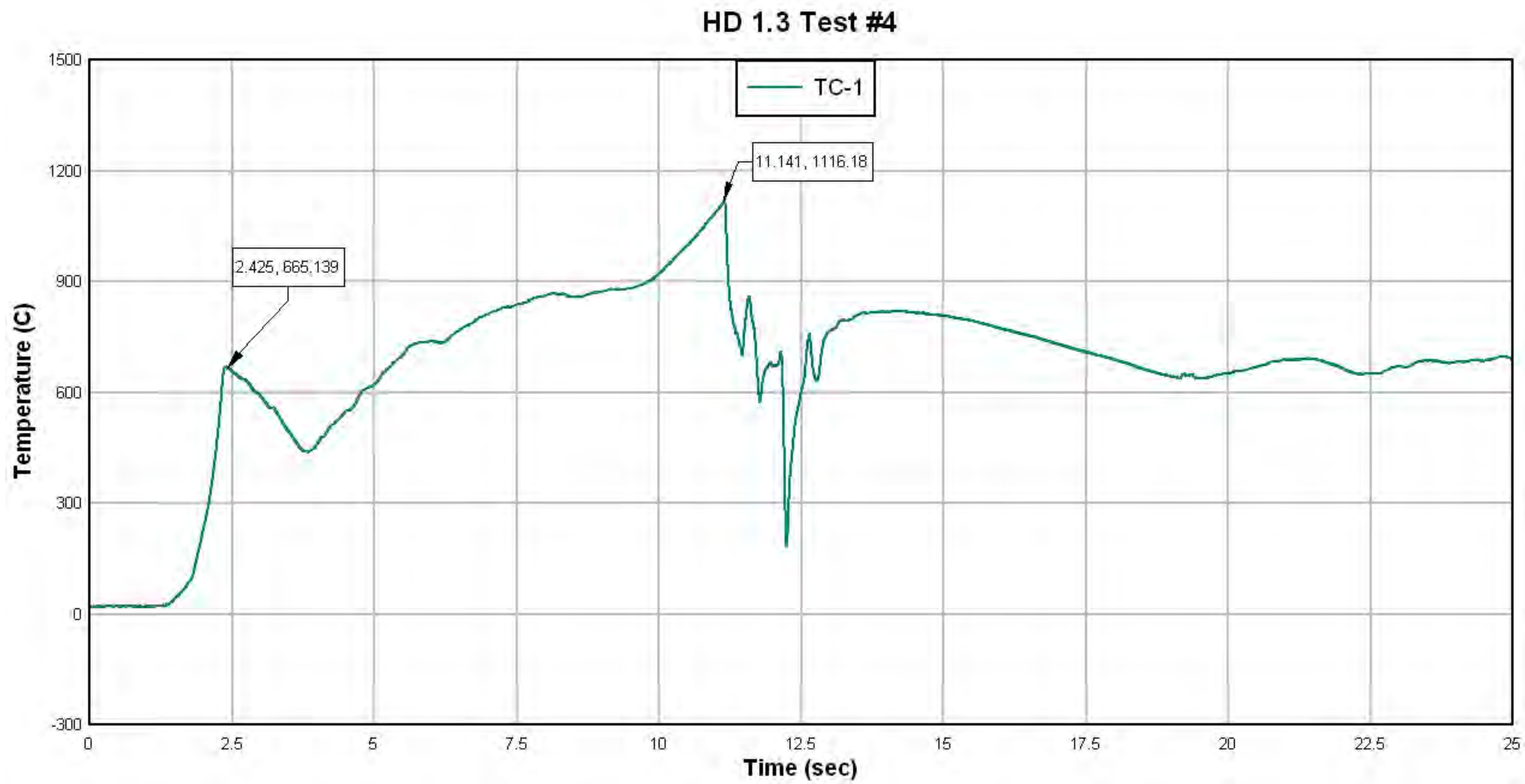

FIGURE V-B-1. Thermocouple #1.

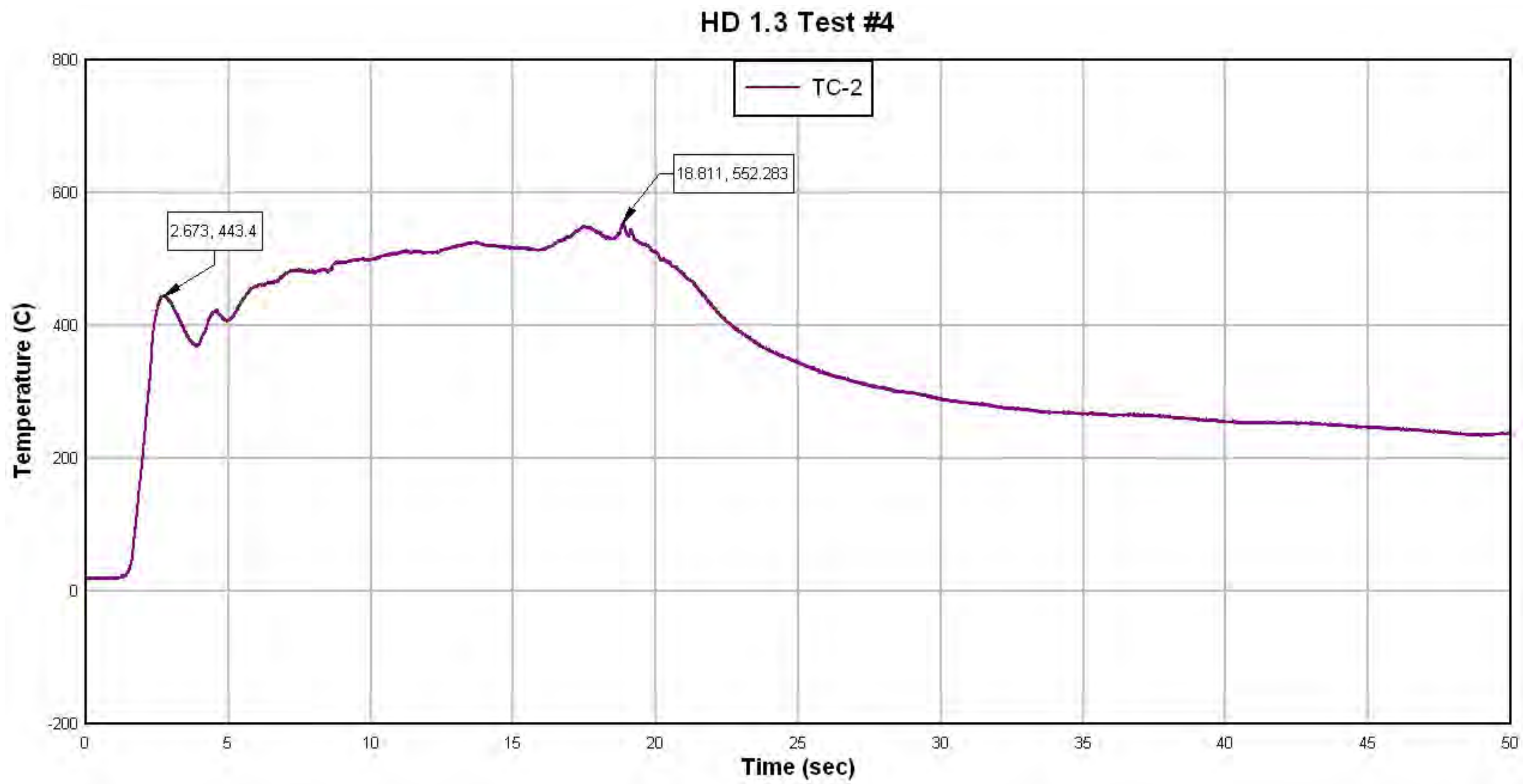

FIGURE V-B-2. Thermocouple #2.

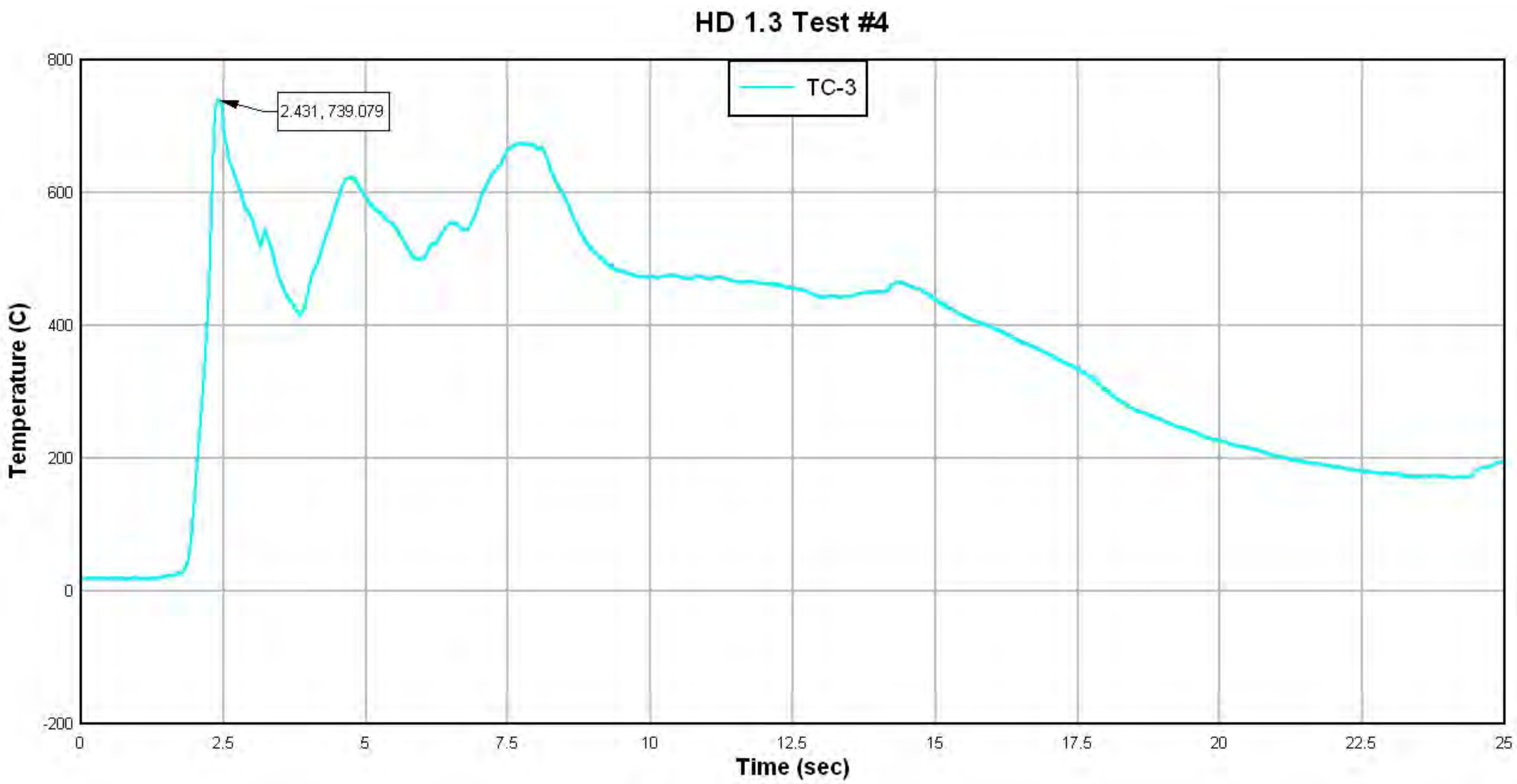

FIGURE V-B-3. Thermocouple #3.

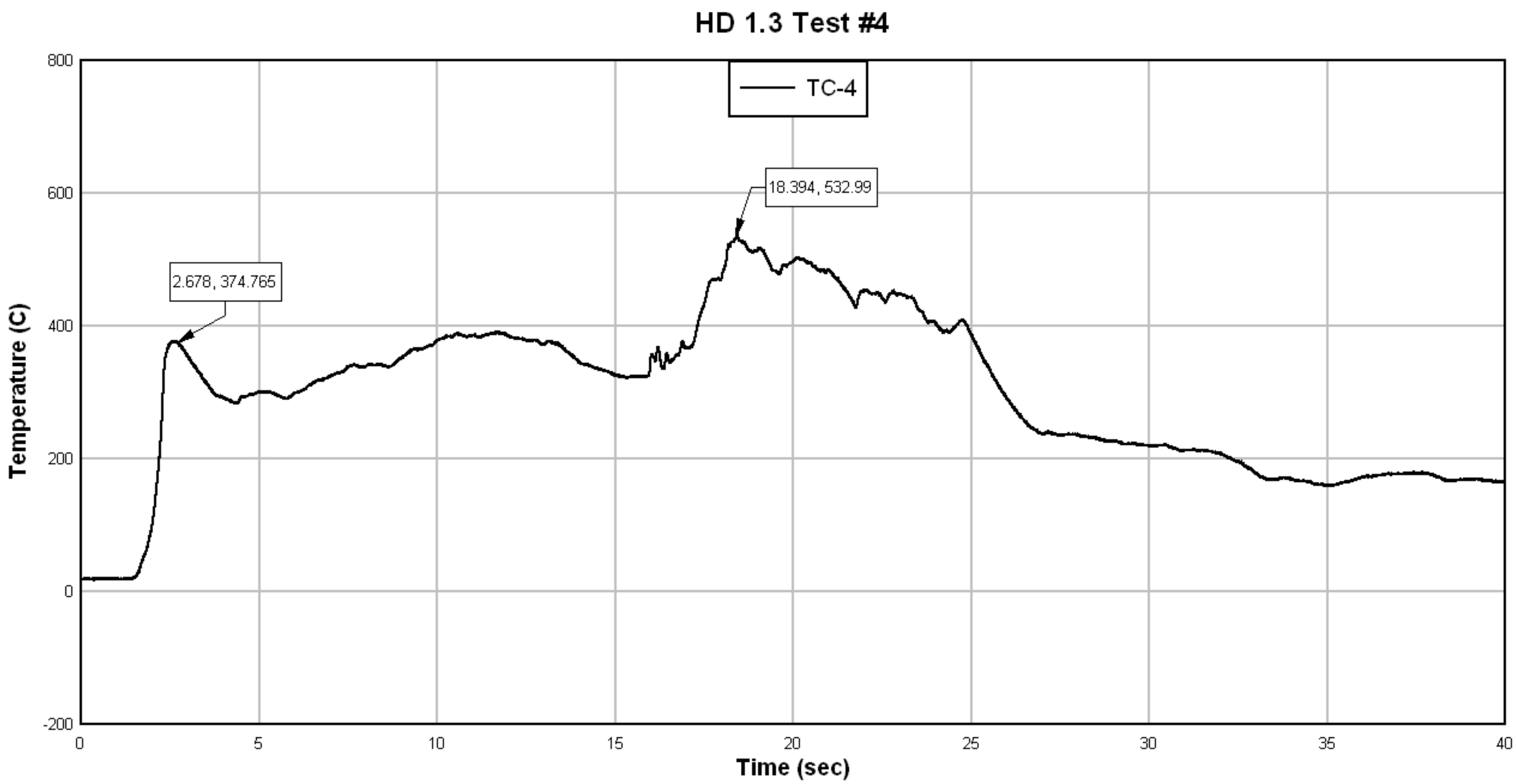

FIGURE V-B-4. Thermocouple #4.

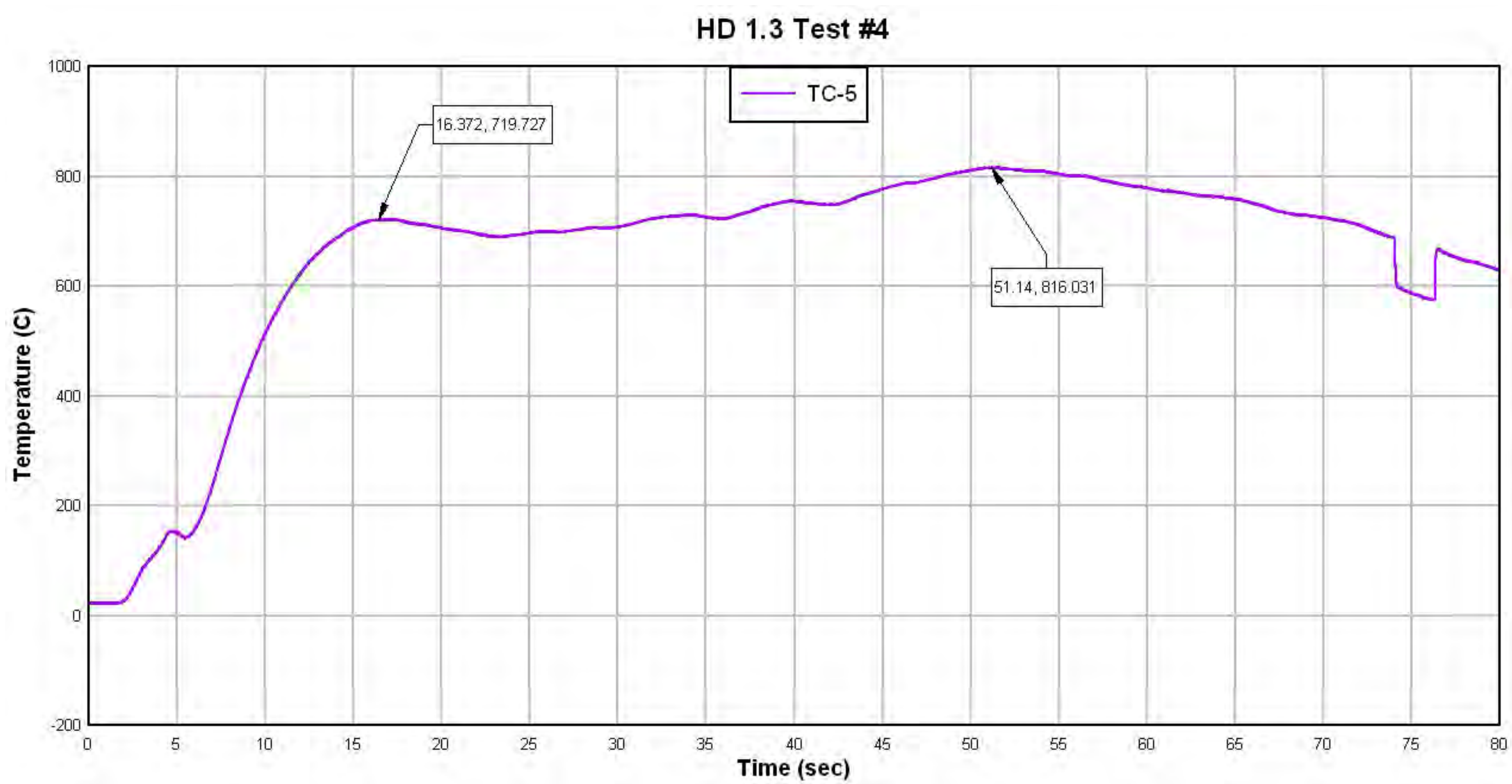

FIGURE V-B-5. Thermocouple #5.

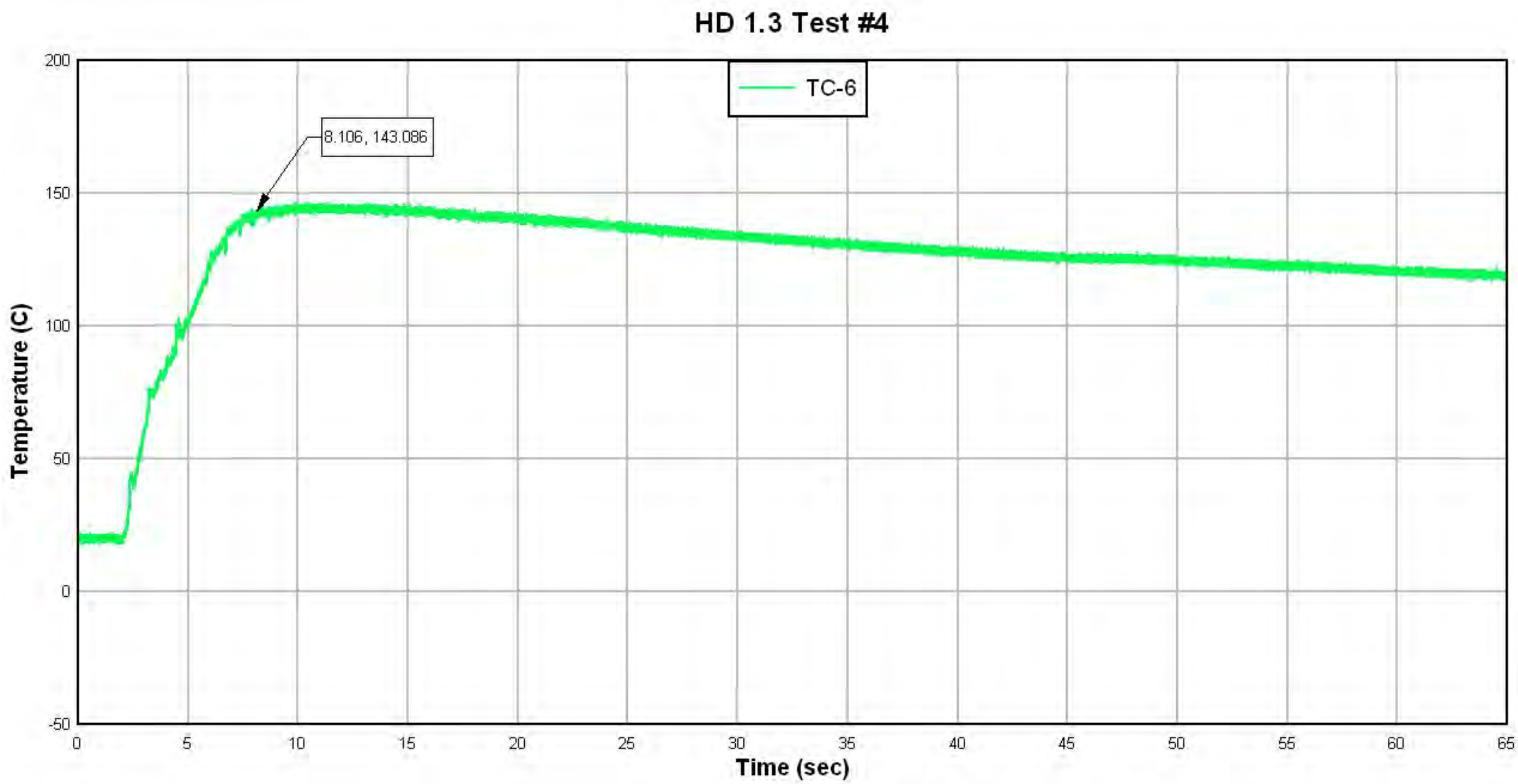

FIGURE V-B-6. Thermocouple #6.

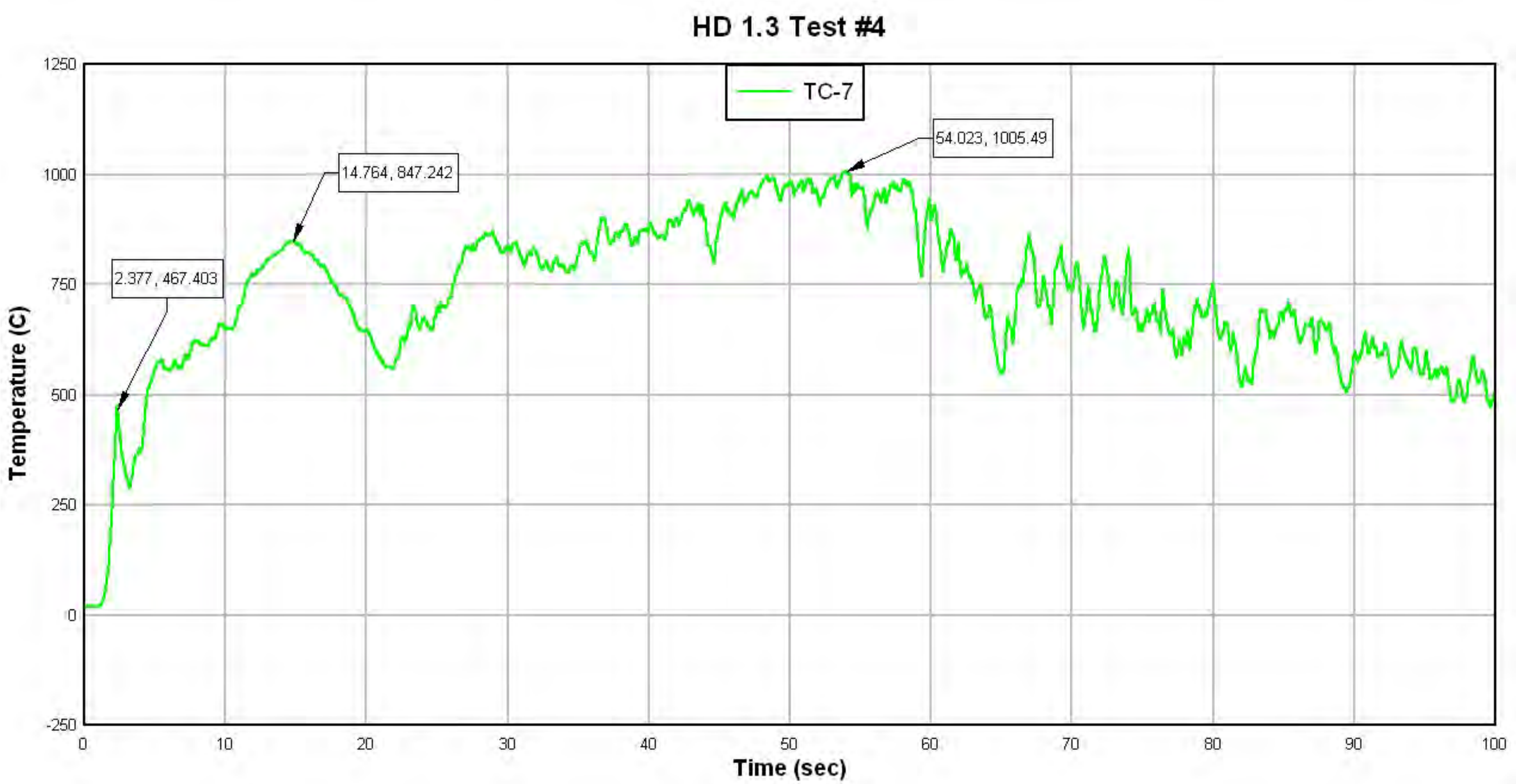

FIGURE V-B-7. Thermocouple #7.

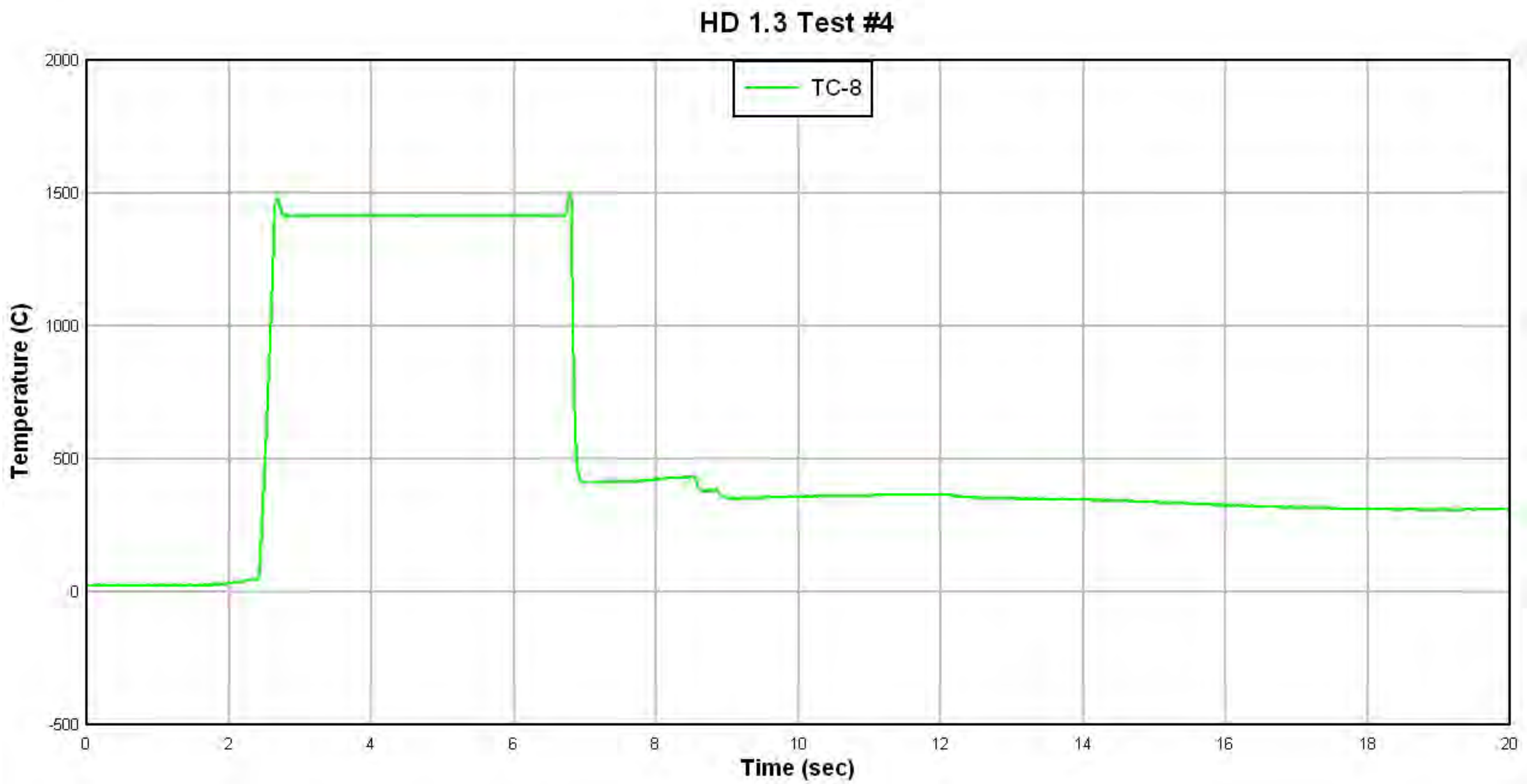

FIGURE V-B-8. Thermocouple #8.

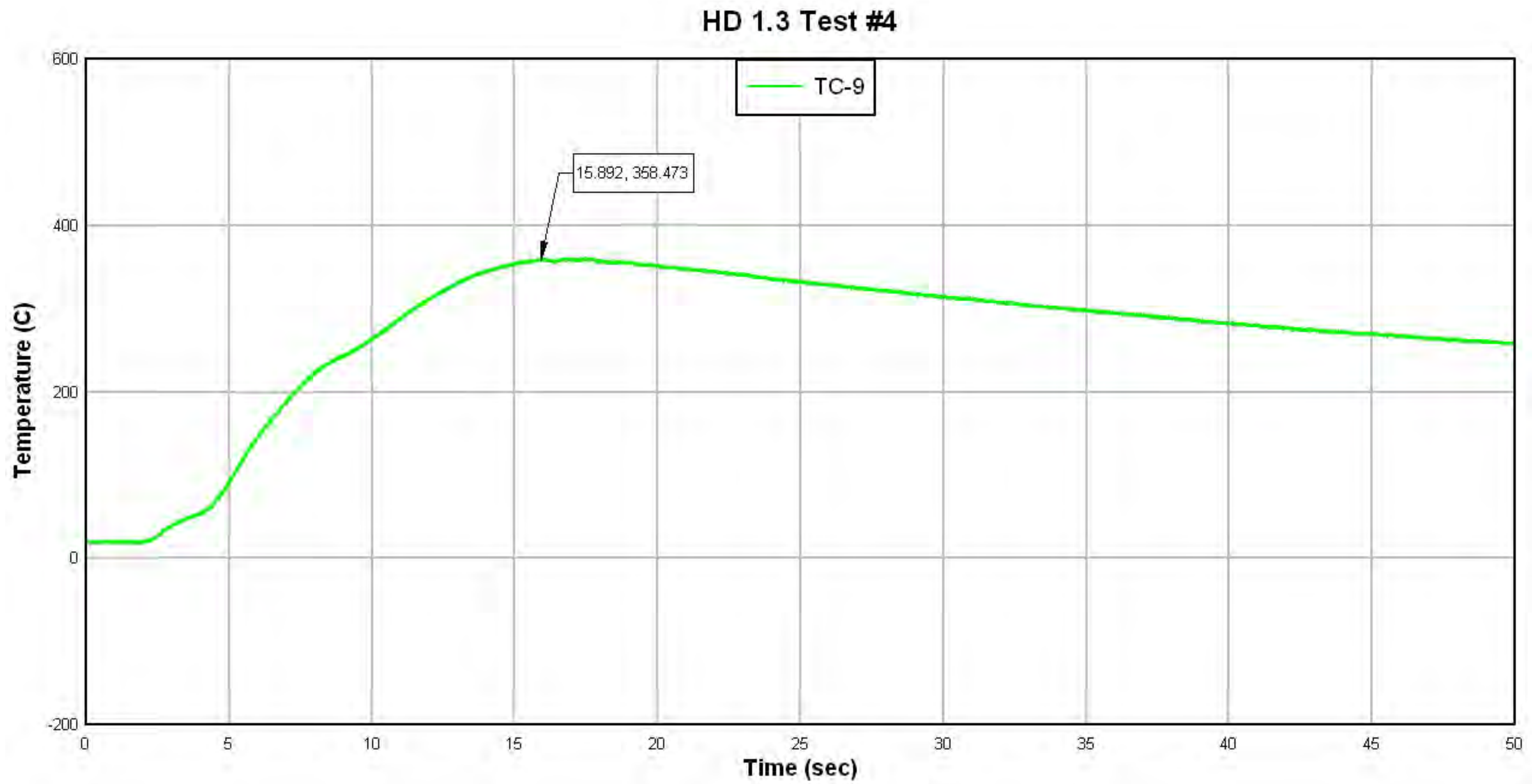

FIGURE V-B-9. Thermocouple #9.

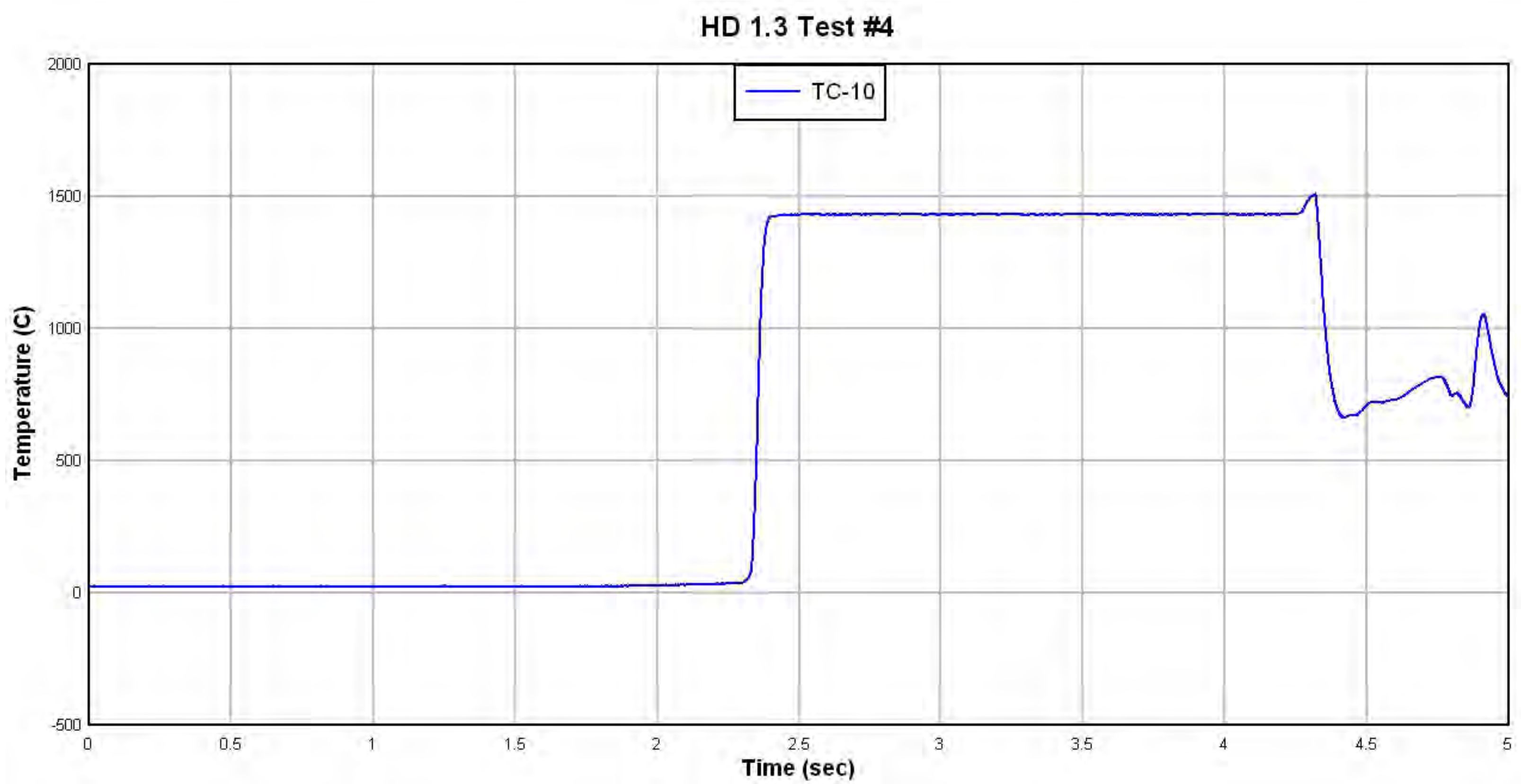

FIGURE V-B-10. Thermocouple #10.

FIGURE V-B-11. Thermocouple #11.

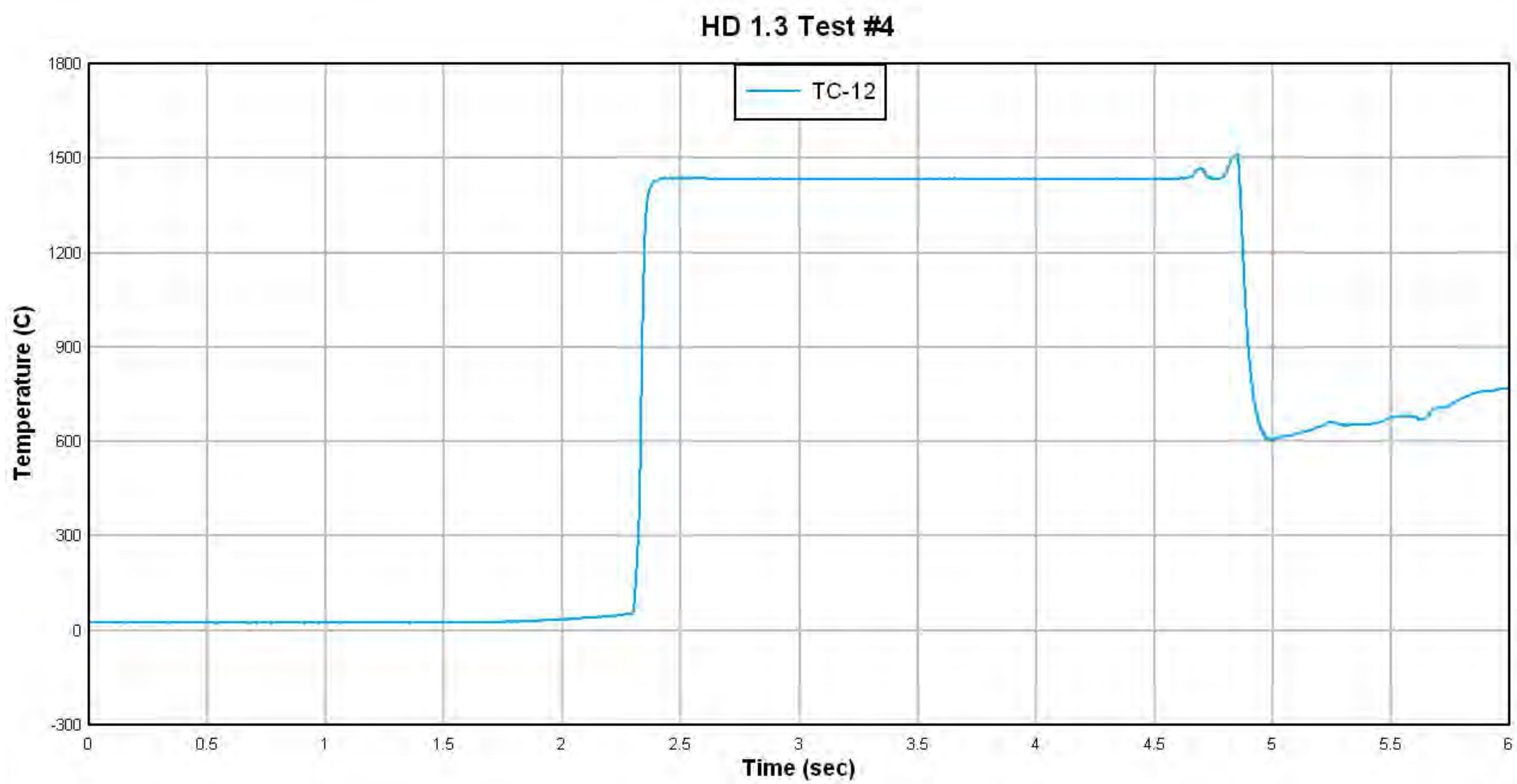

FIGURE V-B-12. Thermocouple #12.

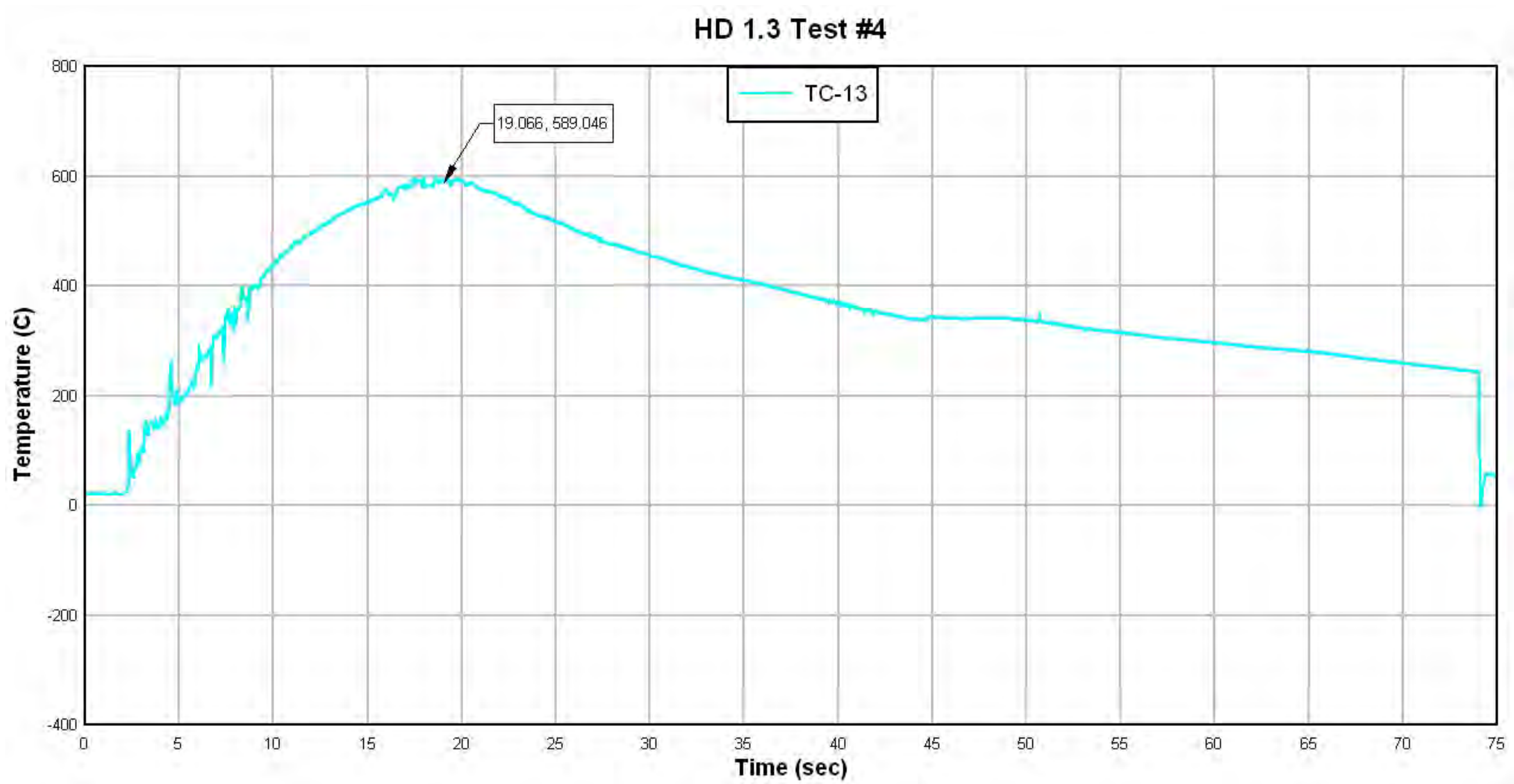

FIGURE V-B-13. Thermocouple #13.

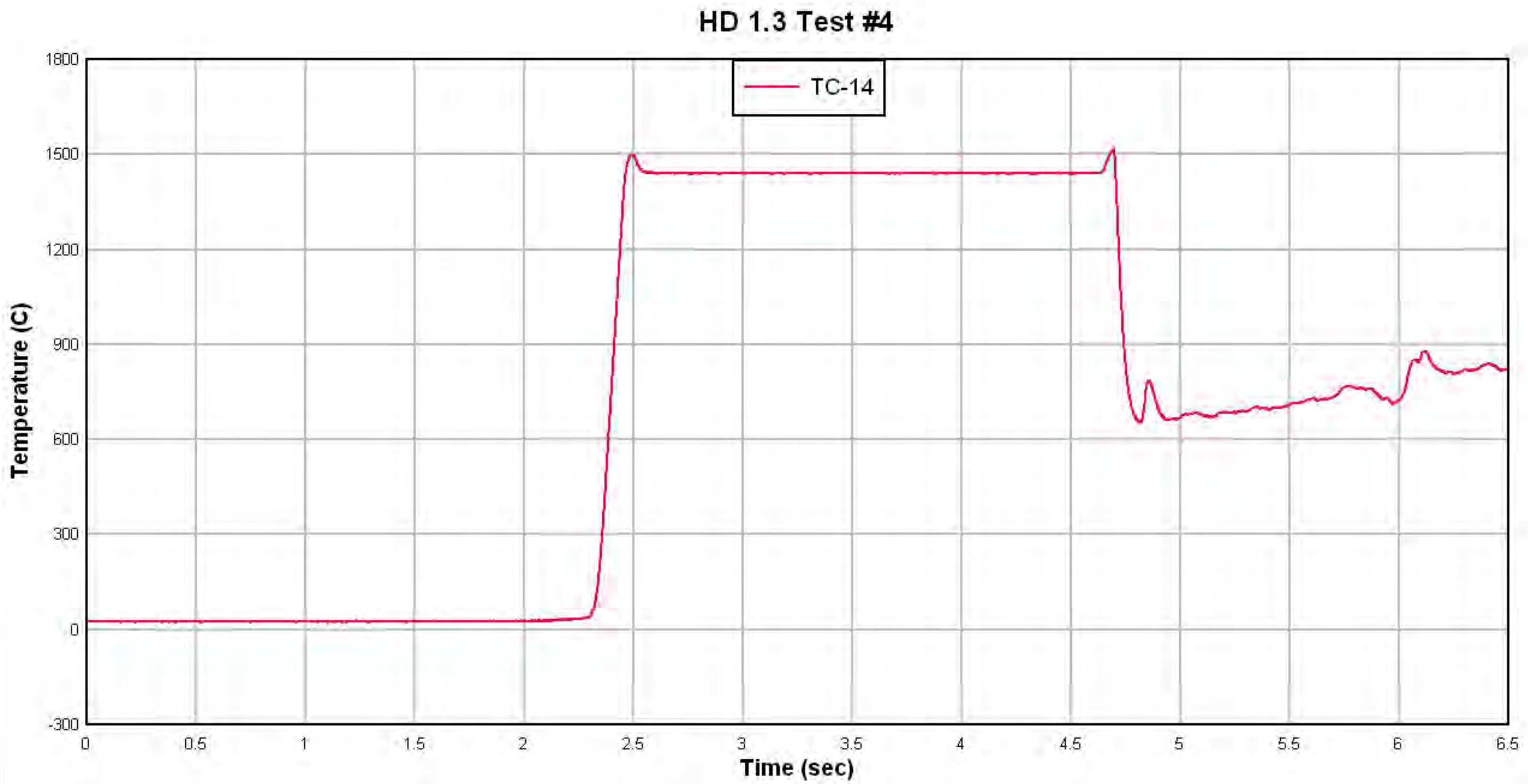

FIGURE V-B-14. Thermocouple #14.

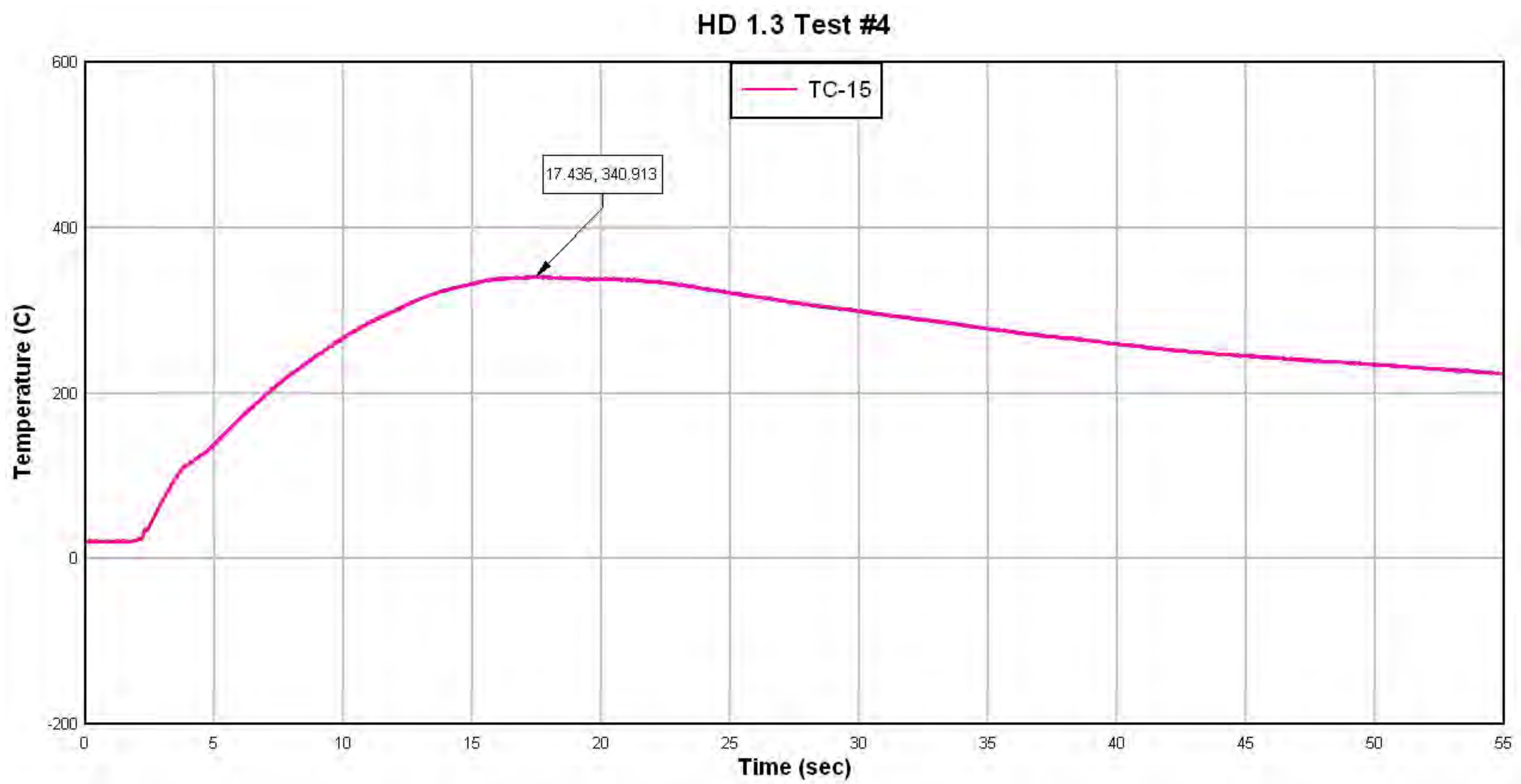

FIGURE V-B-15. Thermocouple #15.

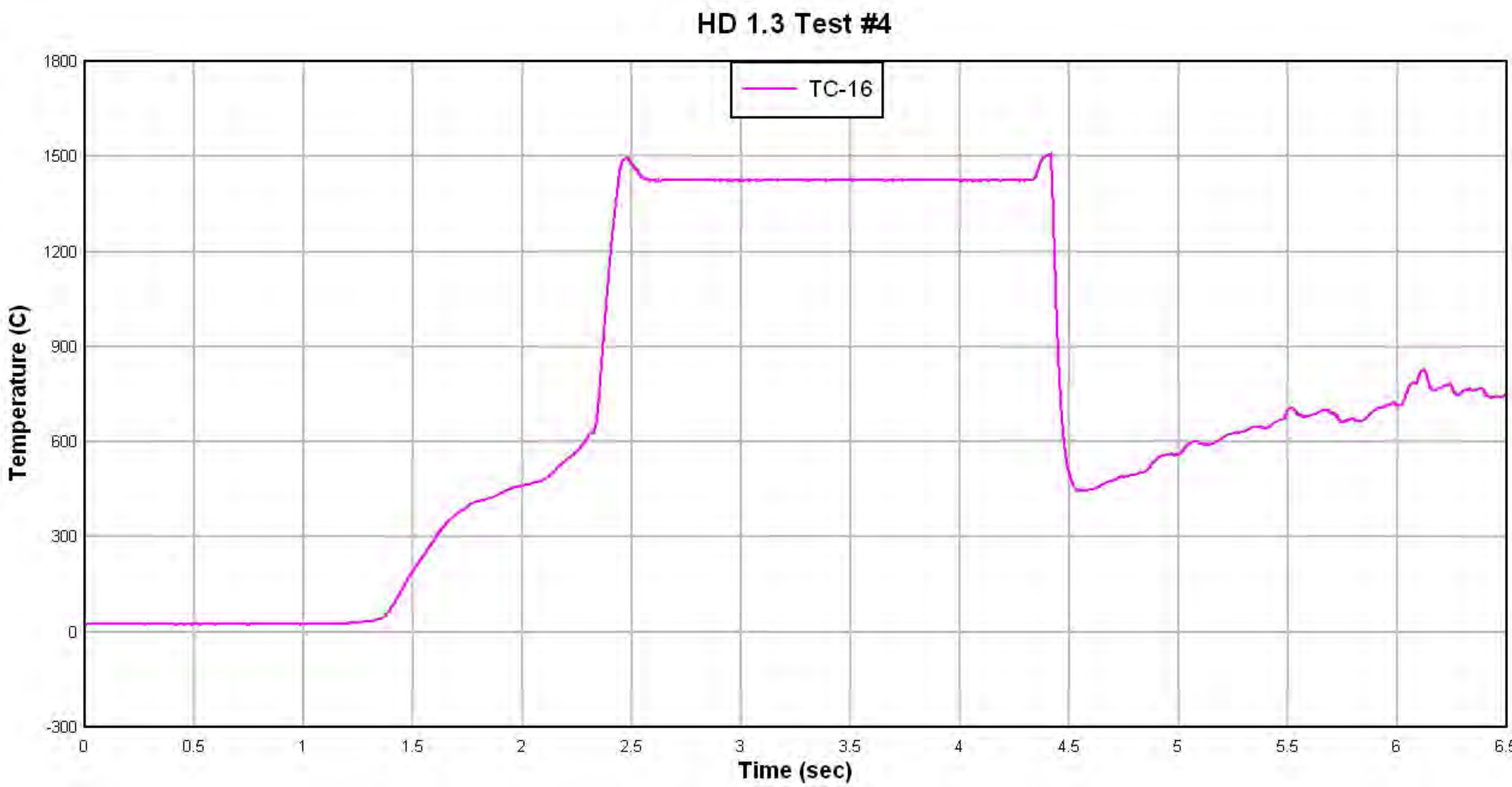

FIGURE V-B-16. Thermocouple #16.

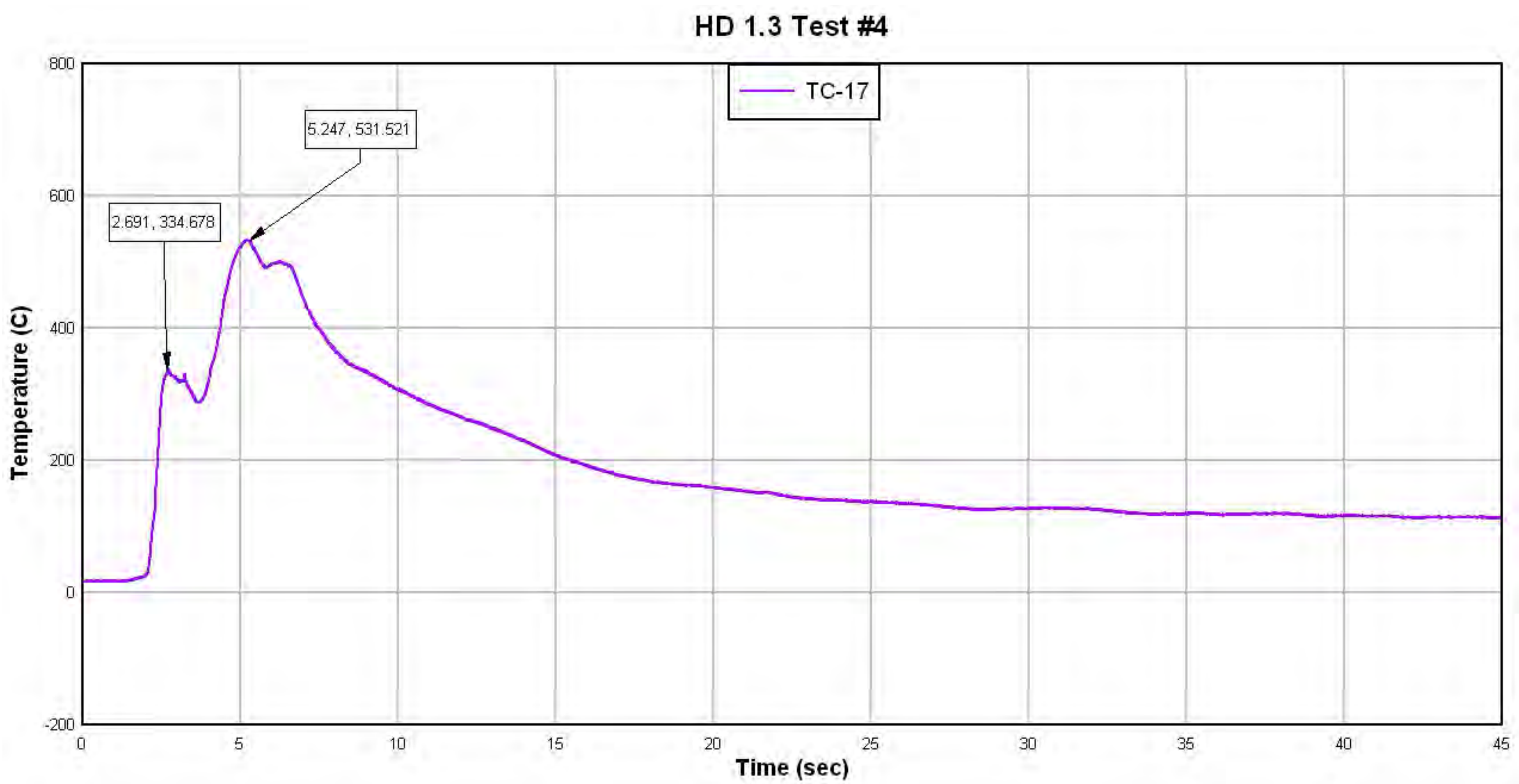

FIGURE V-B-17. Thermocouple #17.

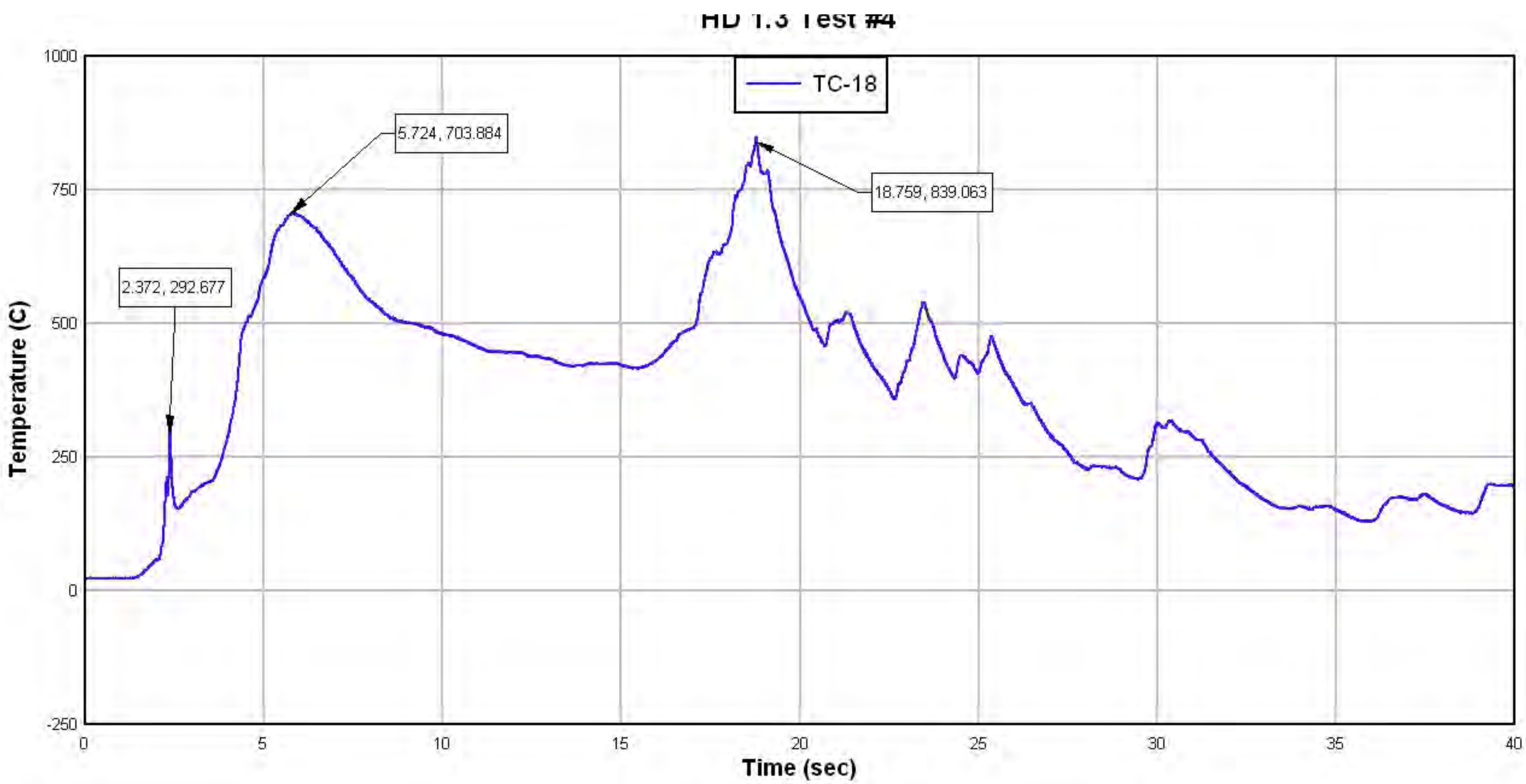

FIGURE V-B-18. Thermocouple #18.

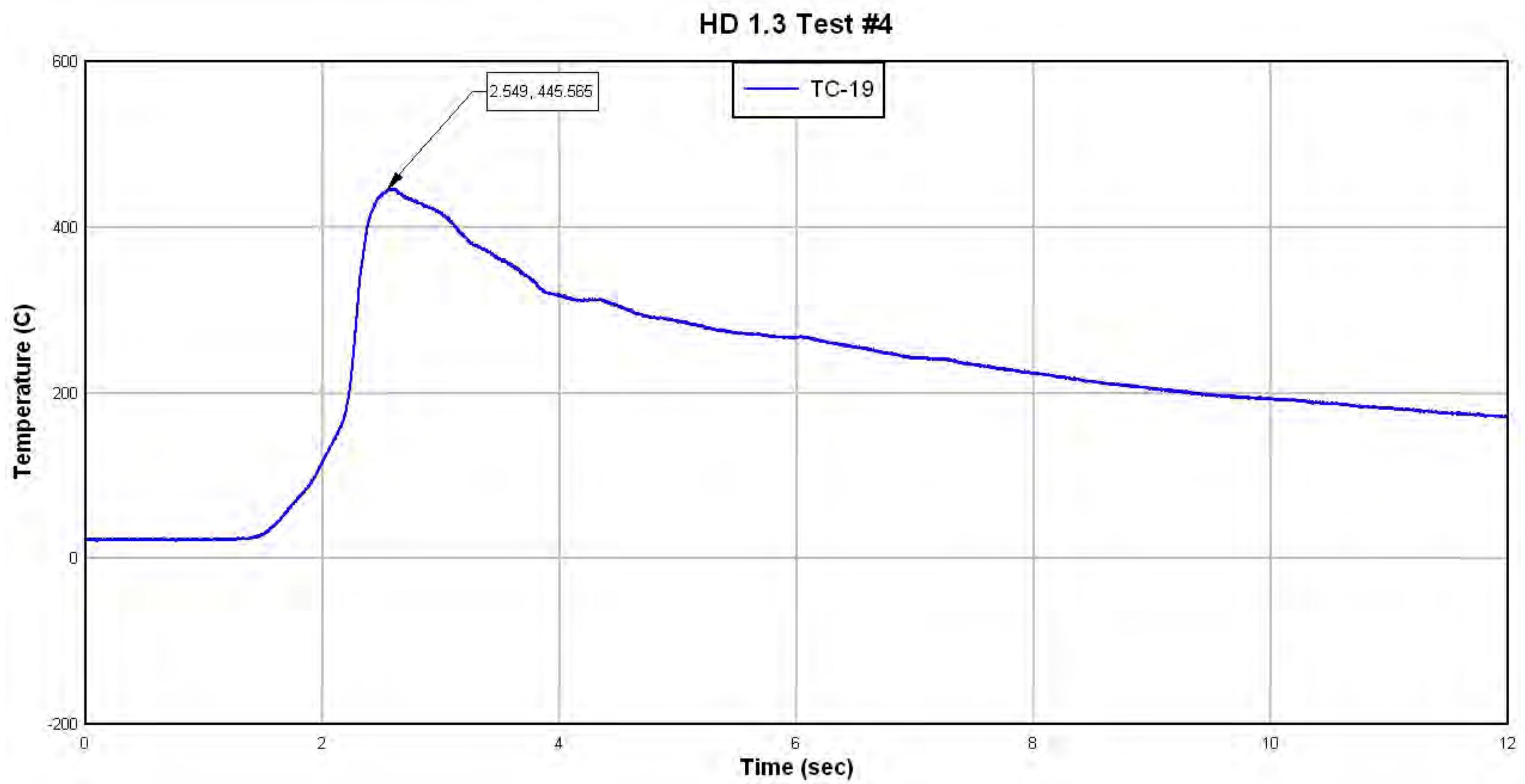

FIGURE V-B-19. Thermocouple #19.

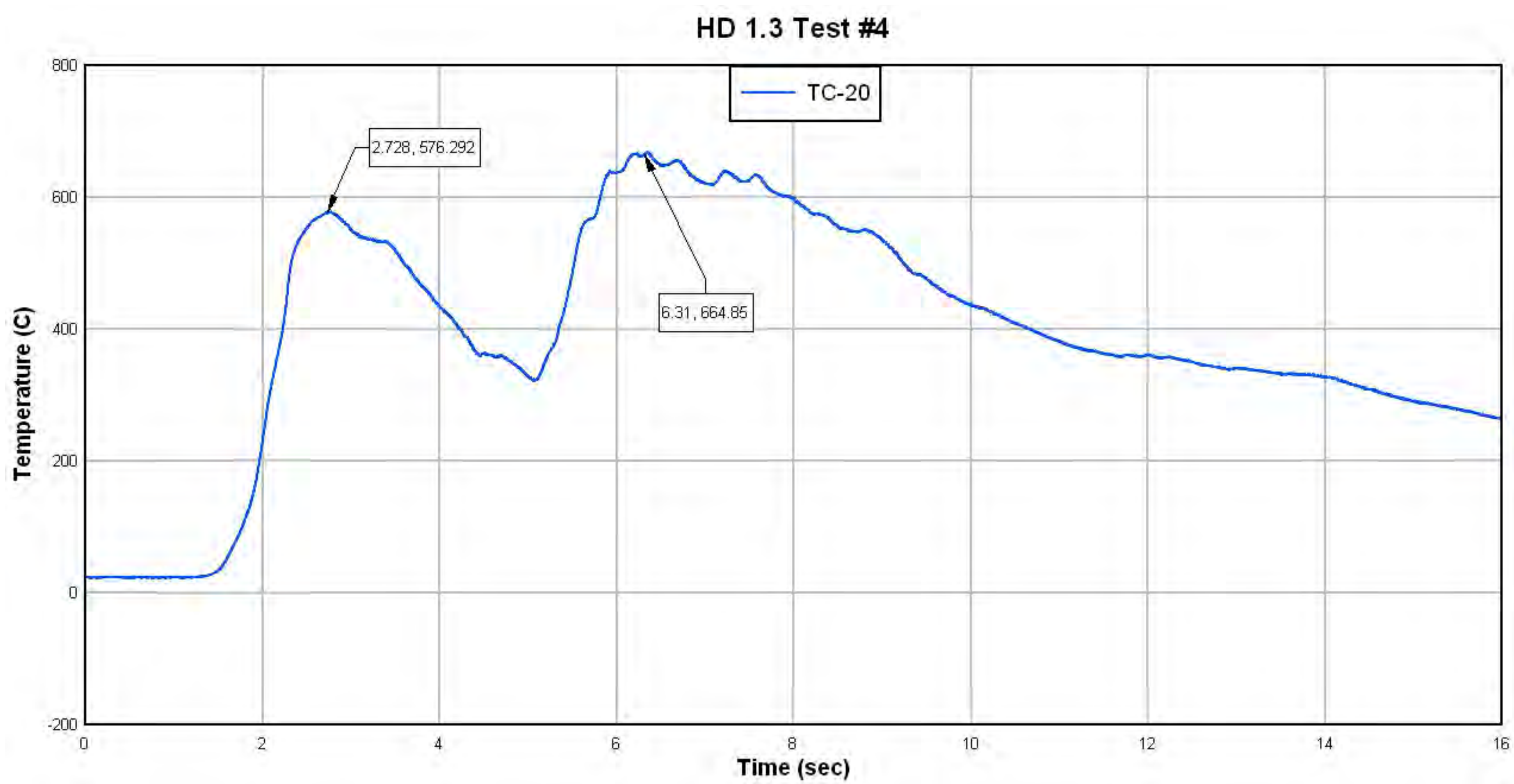

FIGURE V-B-20. Thermocouple #20.

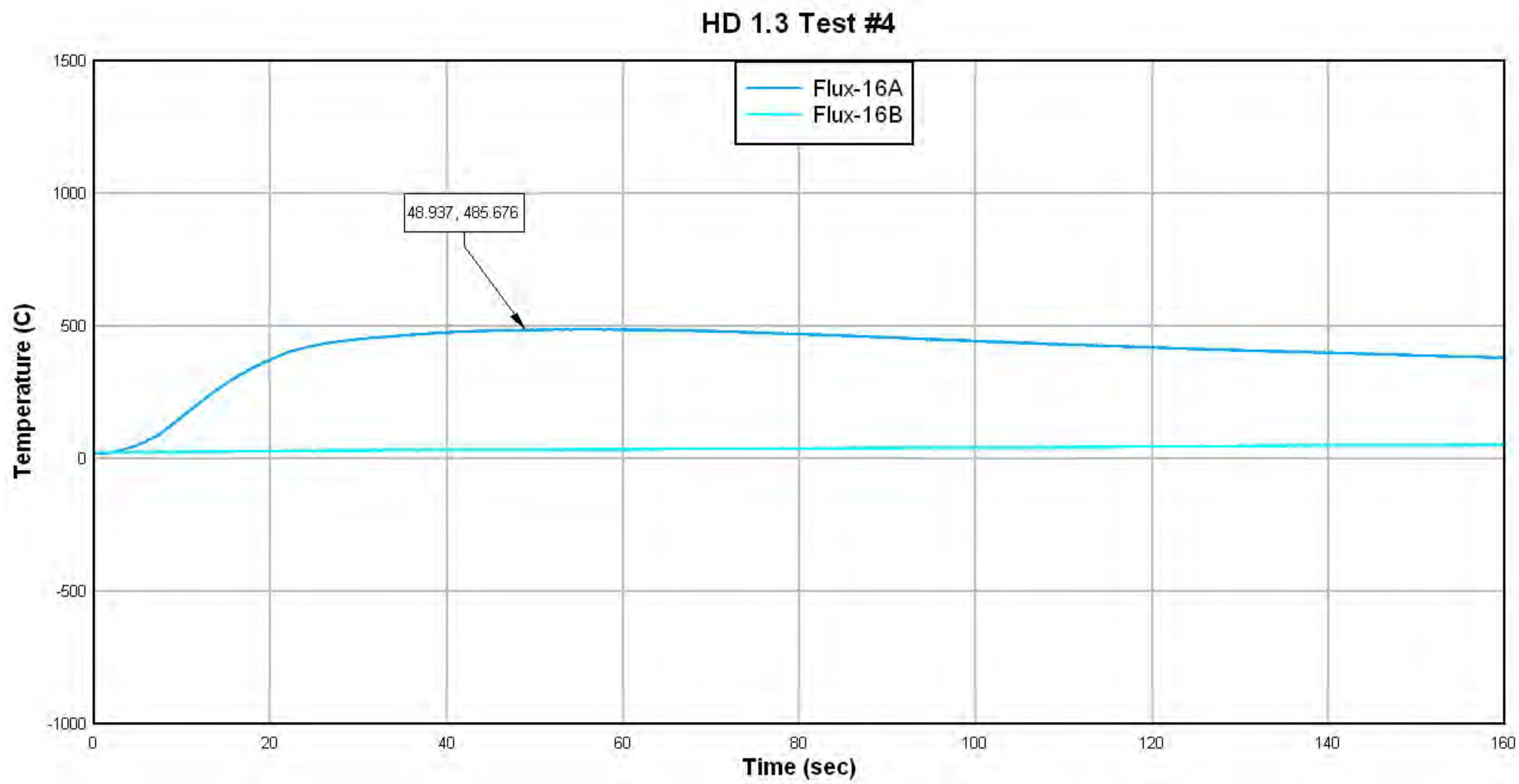

FIGURE V-B-21. Flux Gage #16A and 16B (Inside).

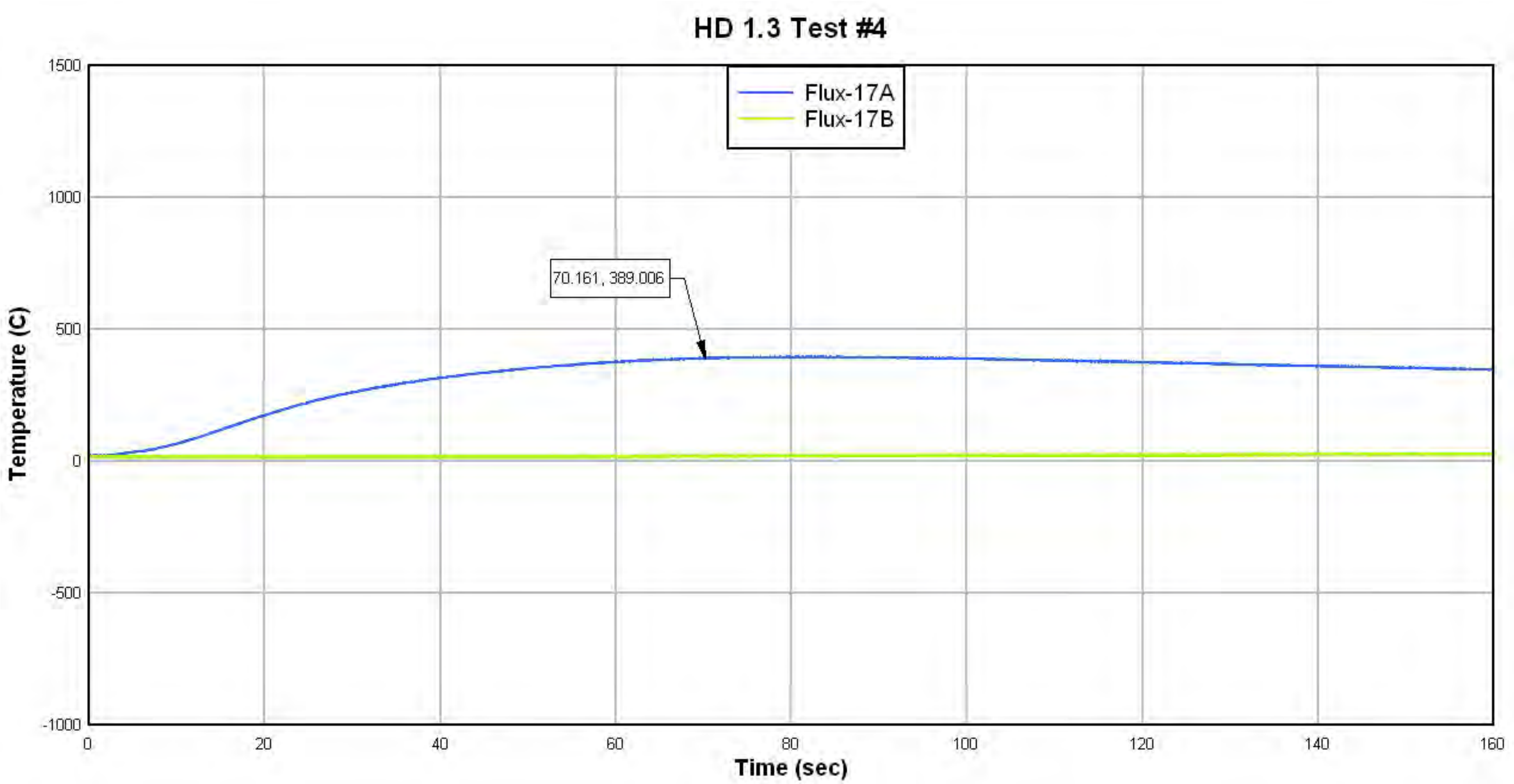

FIGURE V-B-22. Flux Gage #17A and 17B (Inside).

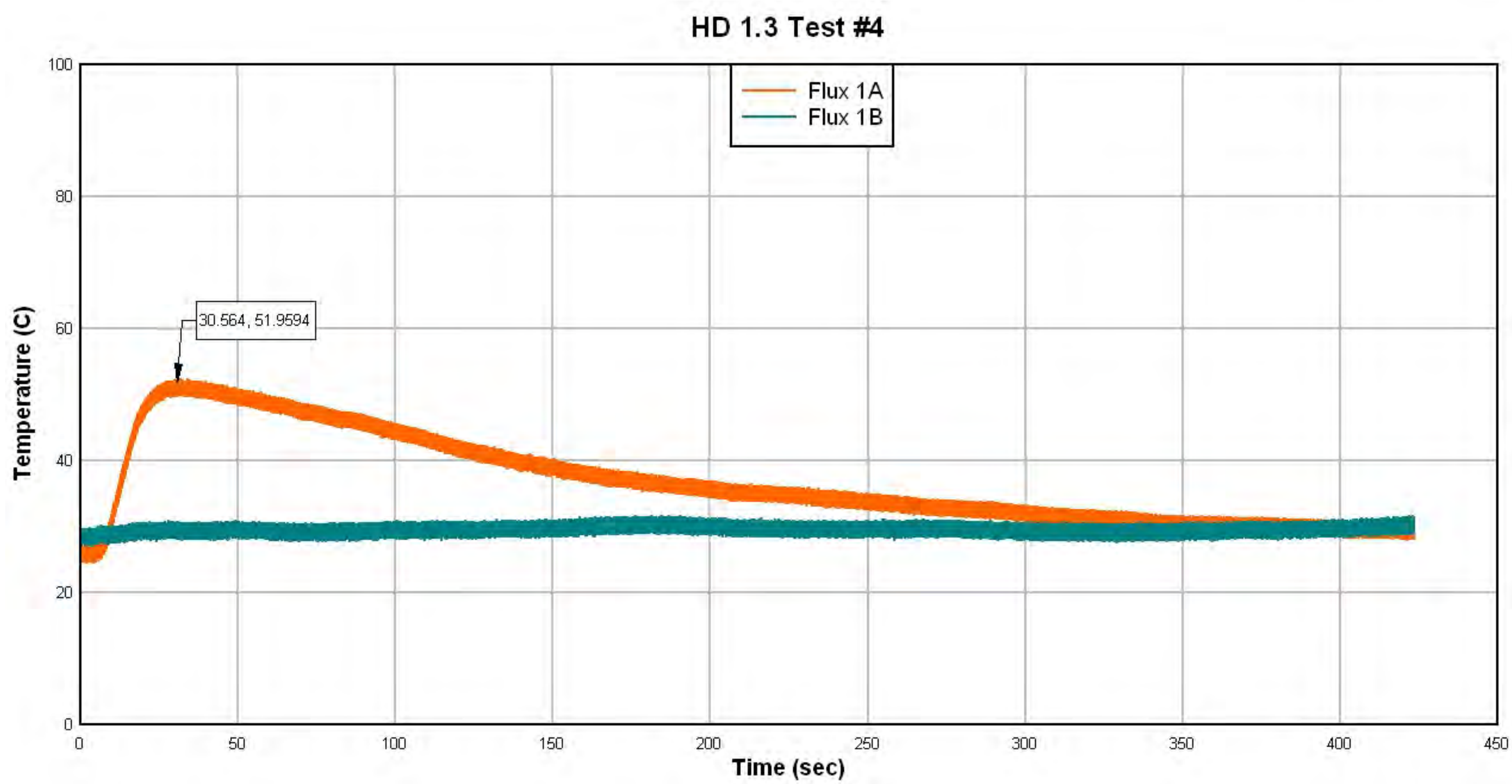

FIGURE V-B-23. Flux Gage #1A and 1B (Outside).

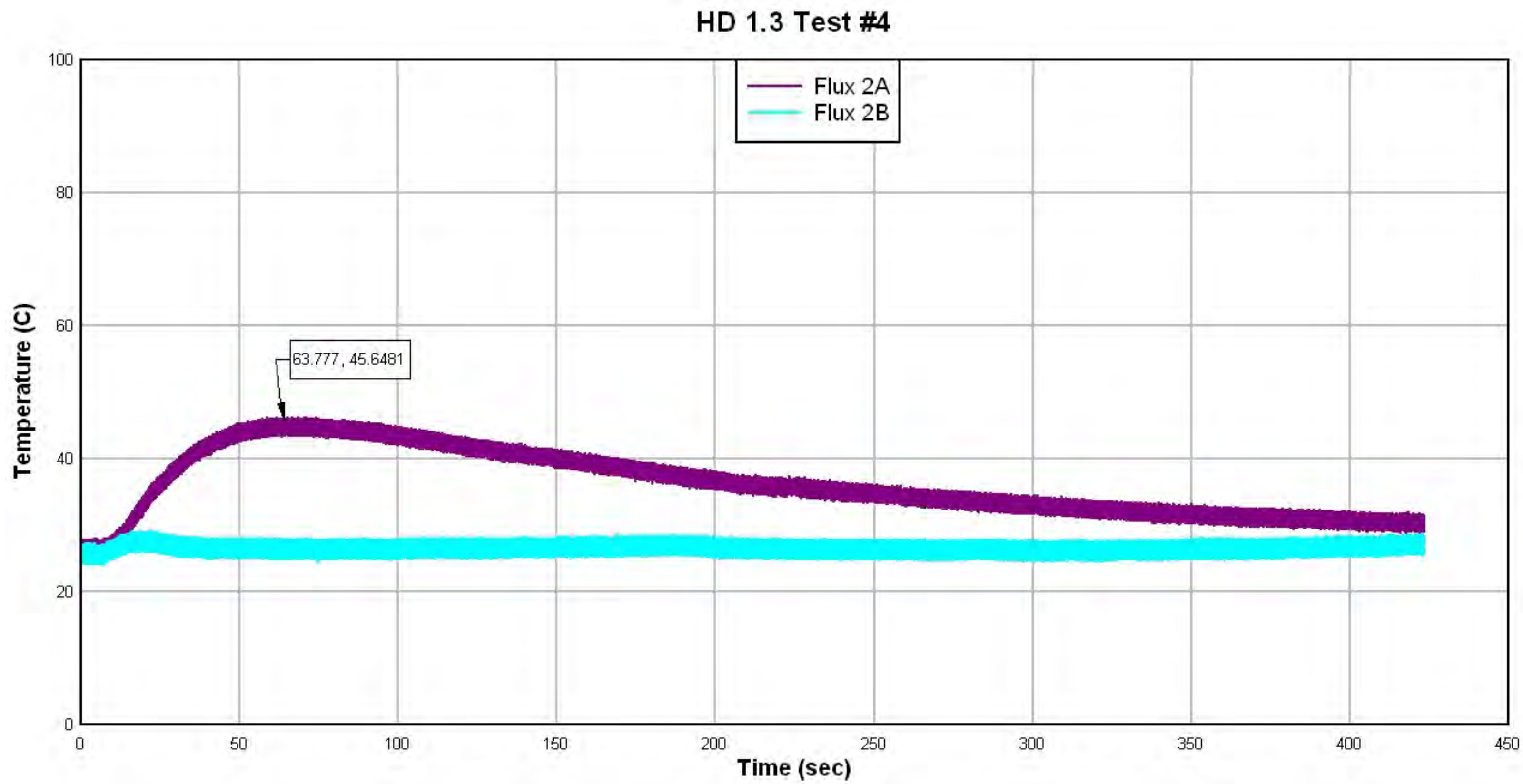

FIGURE V-B-24. Flux Gage #2A and 2B (Outside).

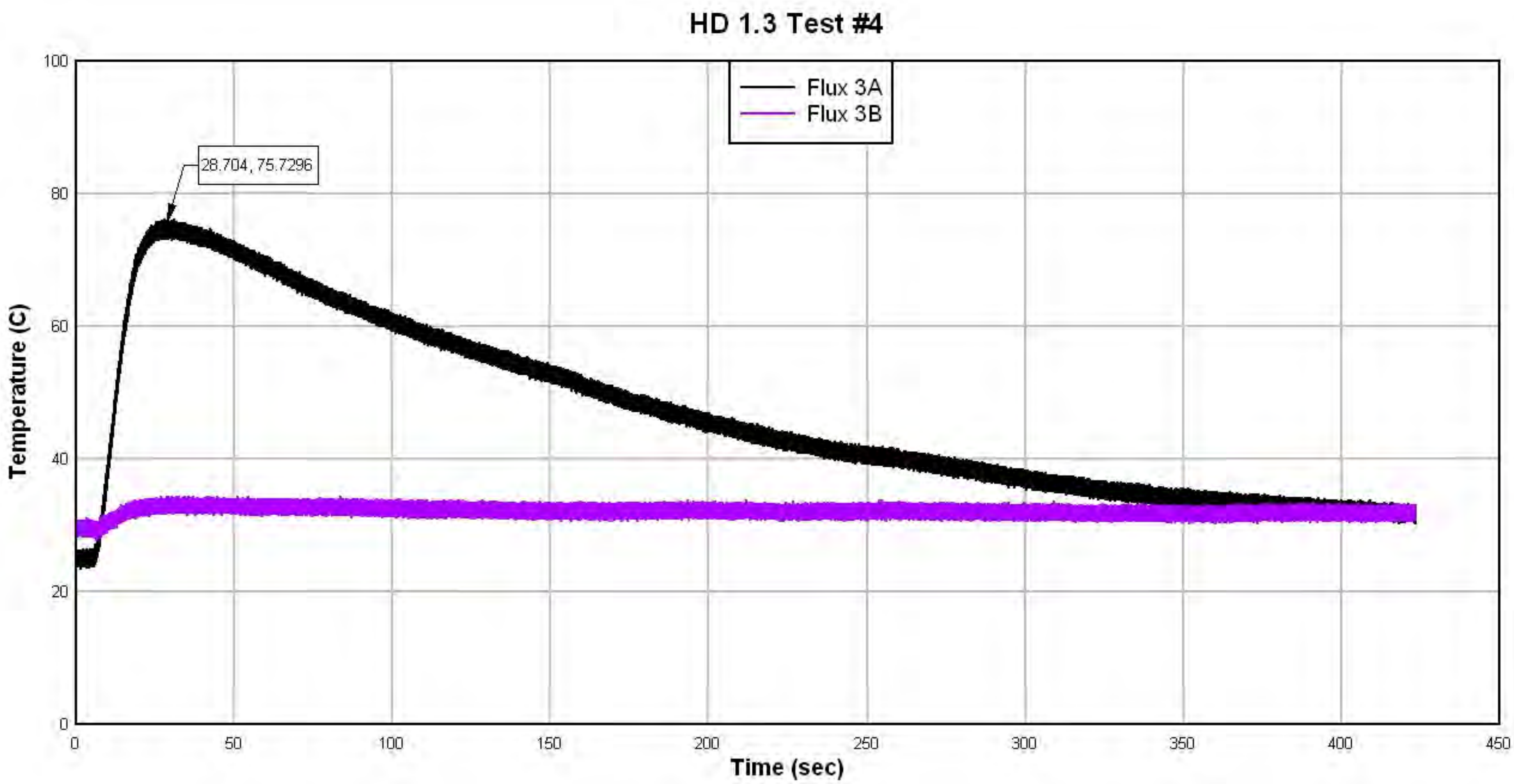

FIGURE V-B-25. Flux Gage #3A and 3B (Outside).

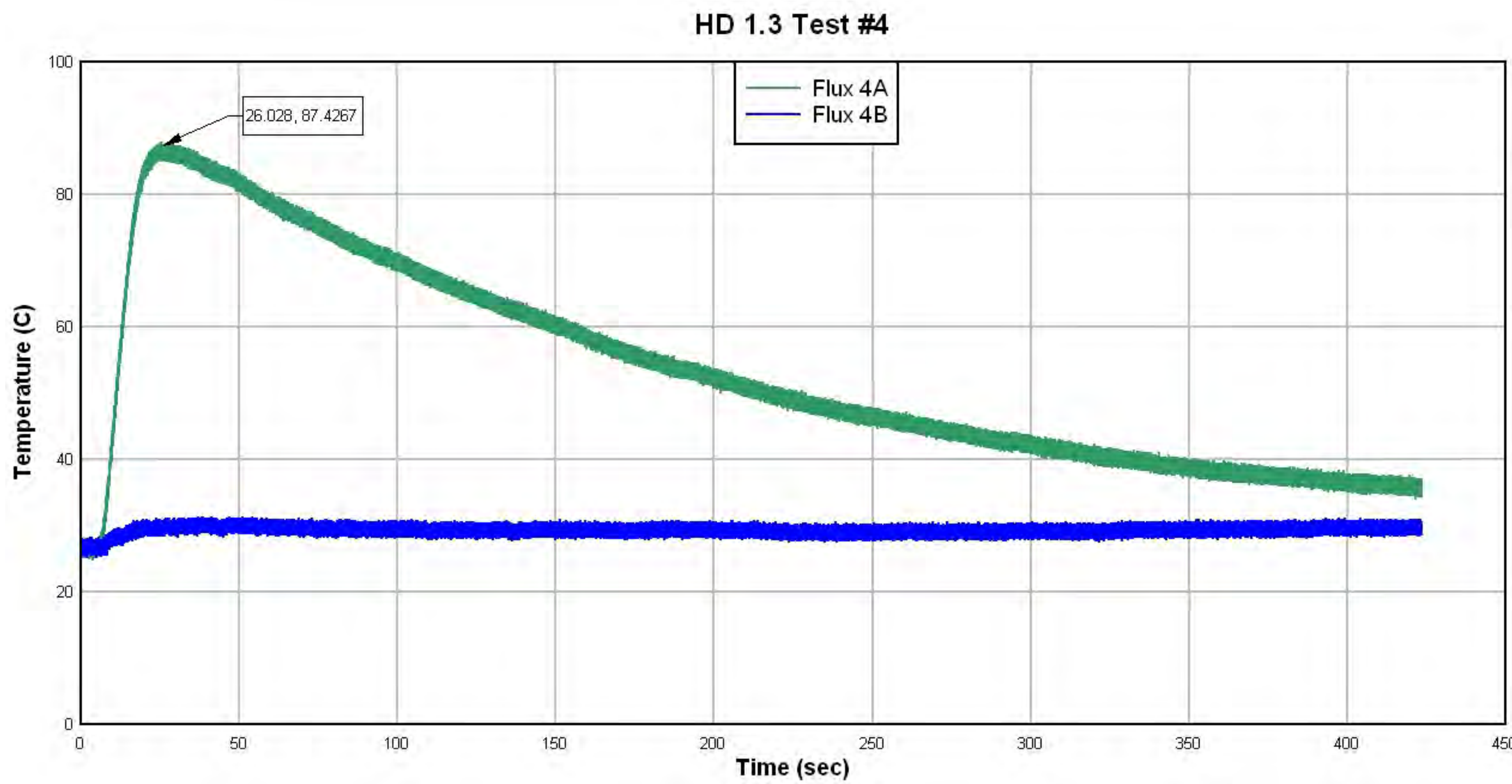

FIGURE V-B-26. Flux Gage #4A and 4B (Outside).

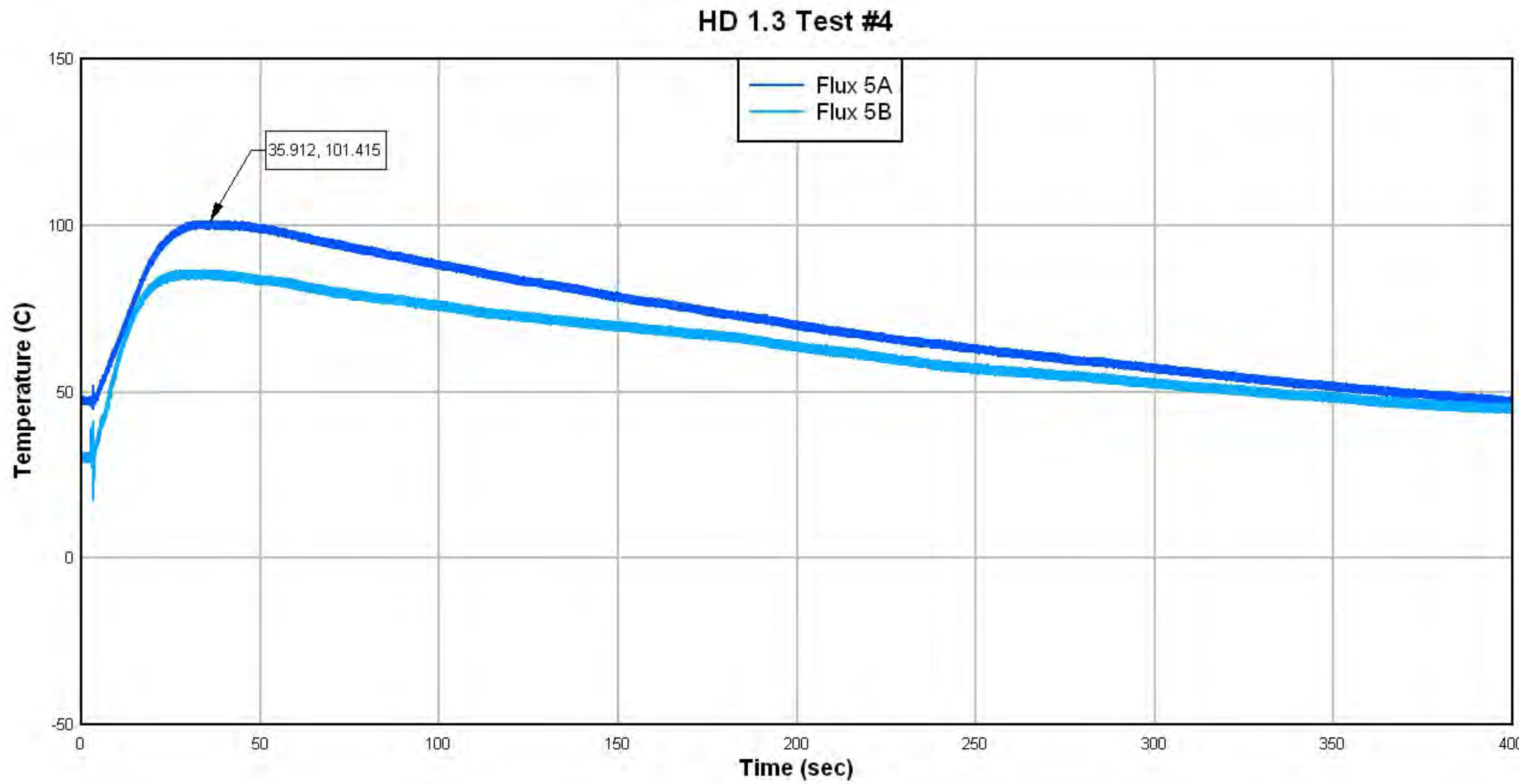

FIGURE V-B-27. Flux Gage #5A and 5B (Outside).

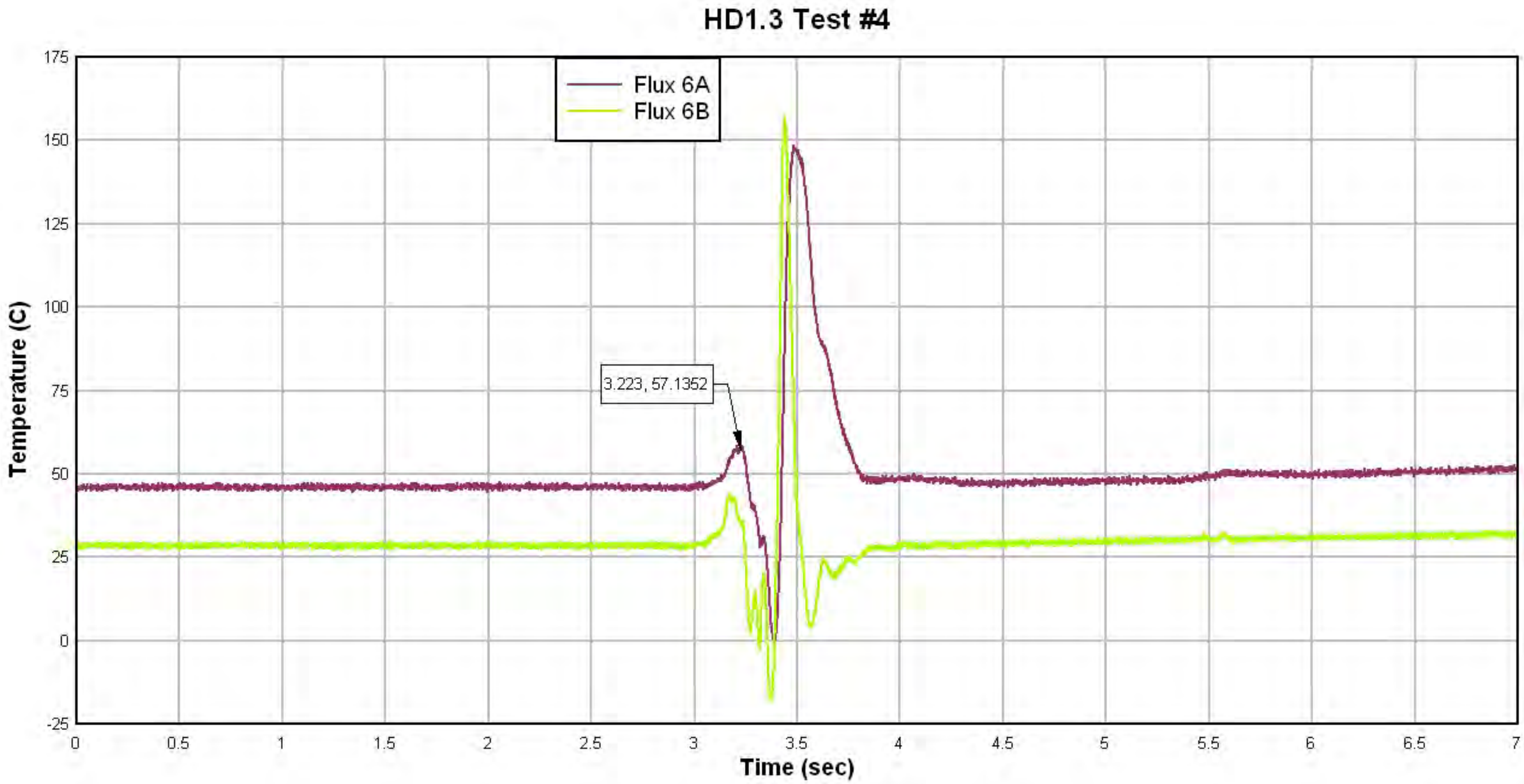

FIGURE V-B-28. Flux Gage #6A and 6B (Outside).

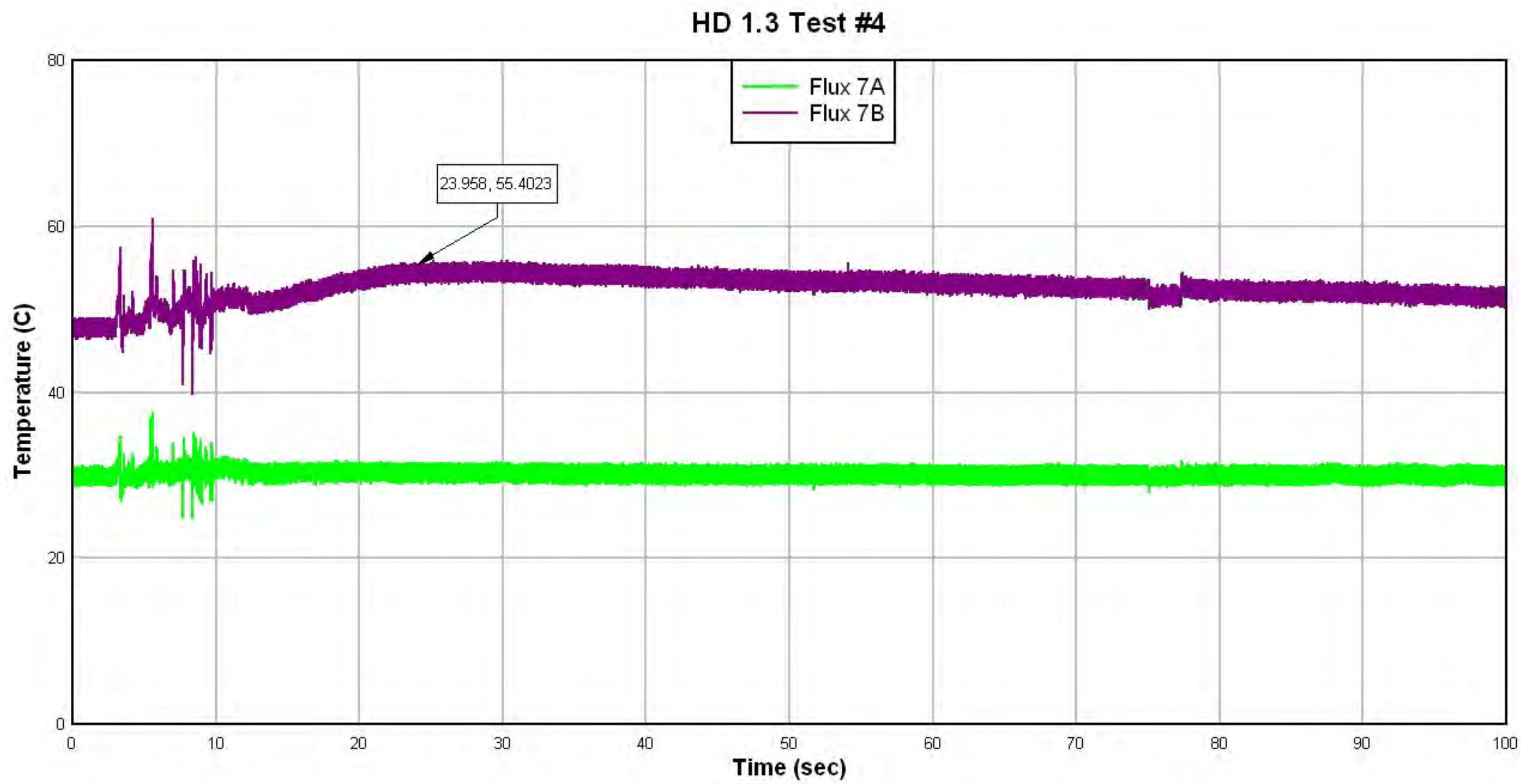

FIGURE V-B-29. Flux Gage #7A and 7B (Outside).

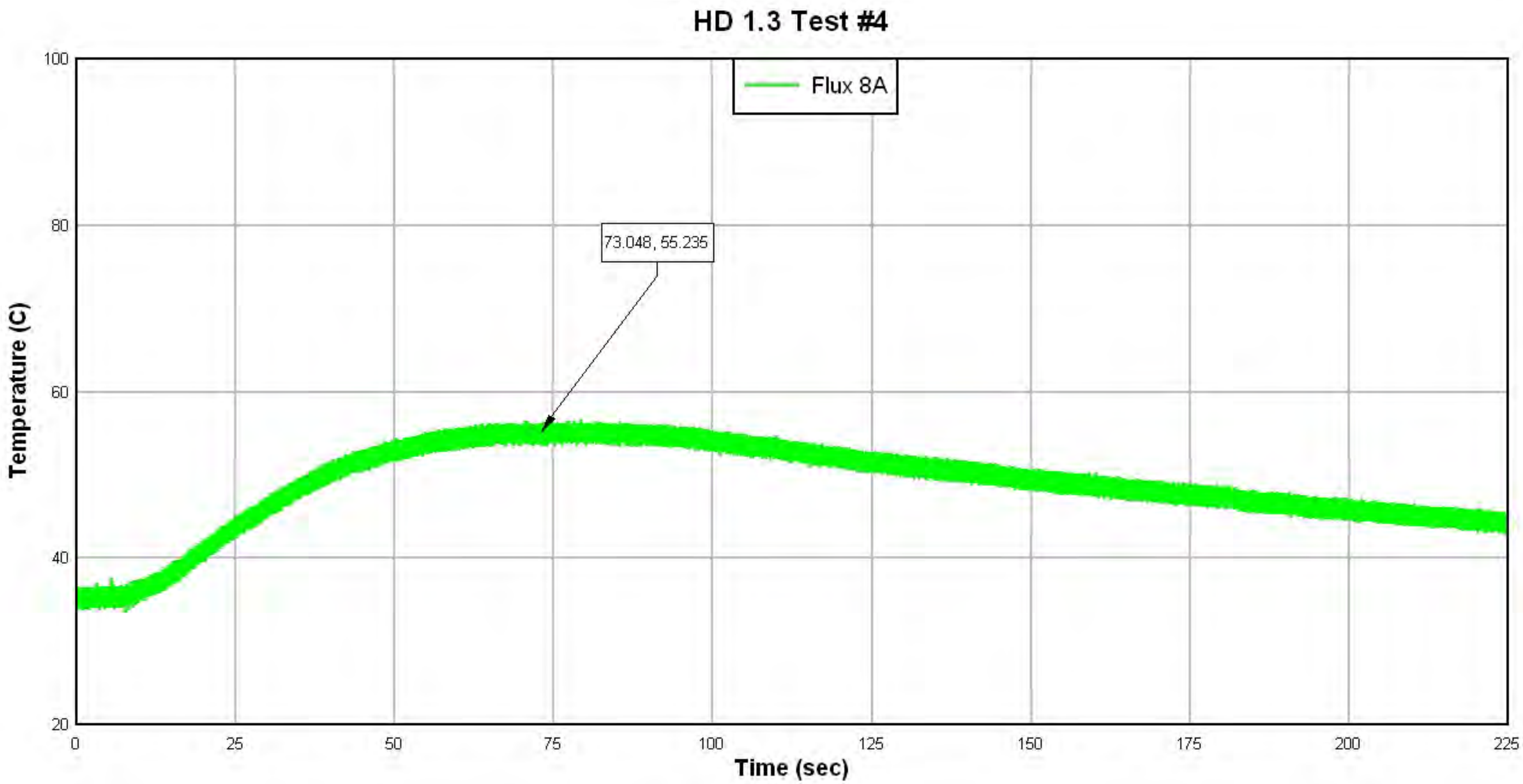

FIGURE V-B-30. Flux Gage #8A (Outside).

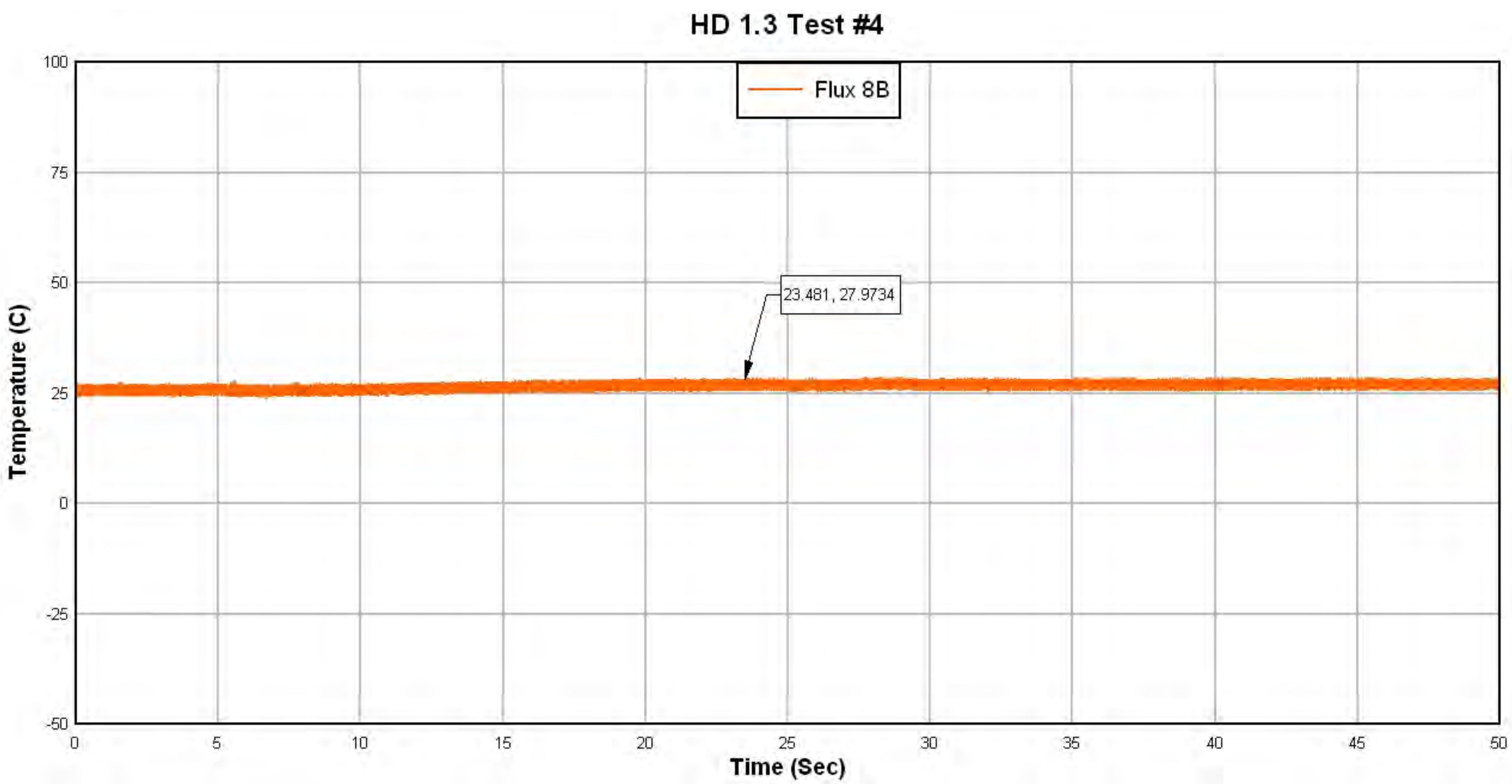

FIGURE V-B-31. Flux Gage #8B (Outside).

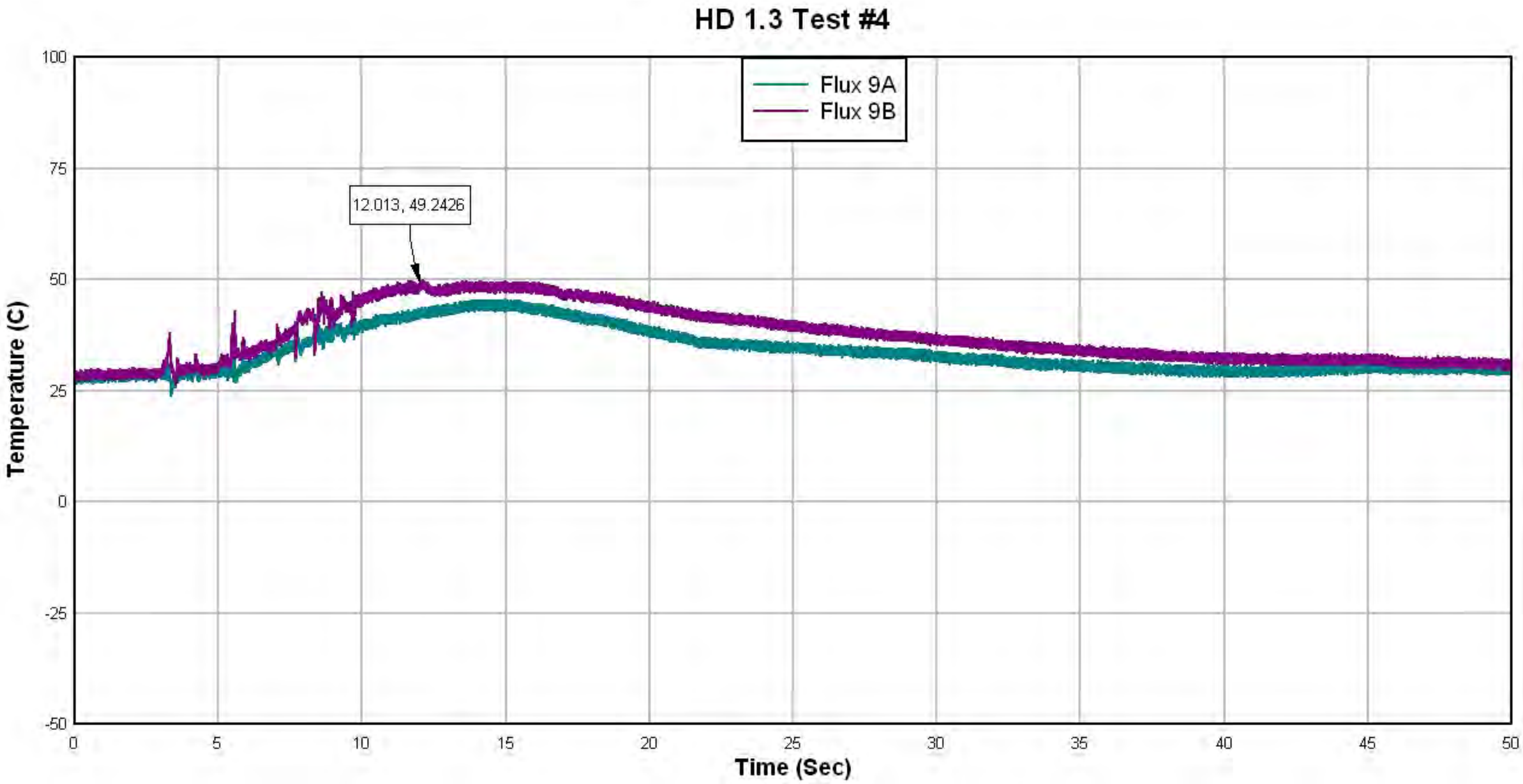

FIGURE V-B-32. Flux Gage #9A and 9B (Outside).

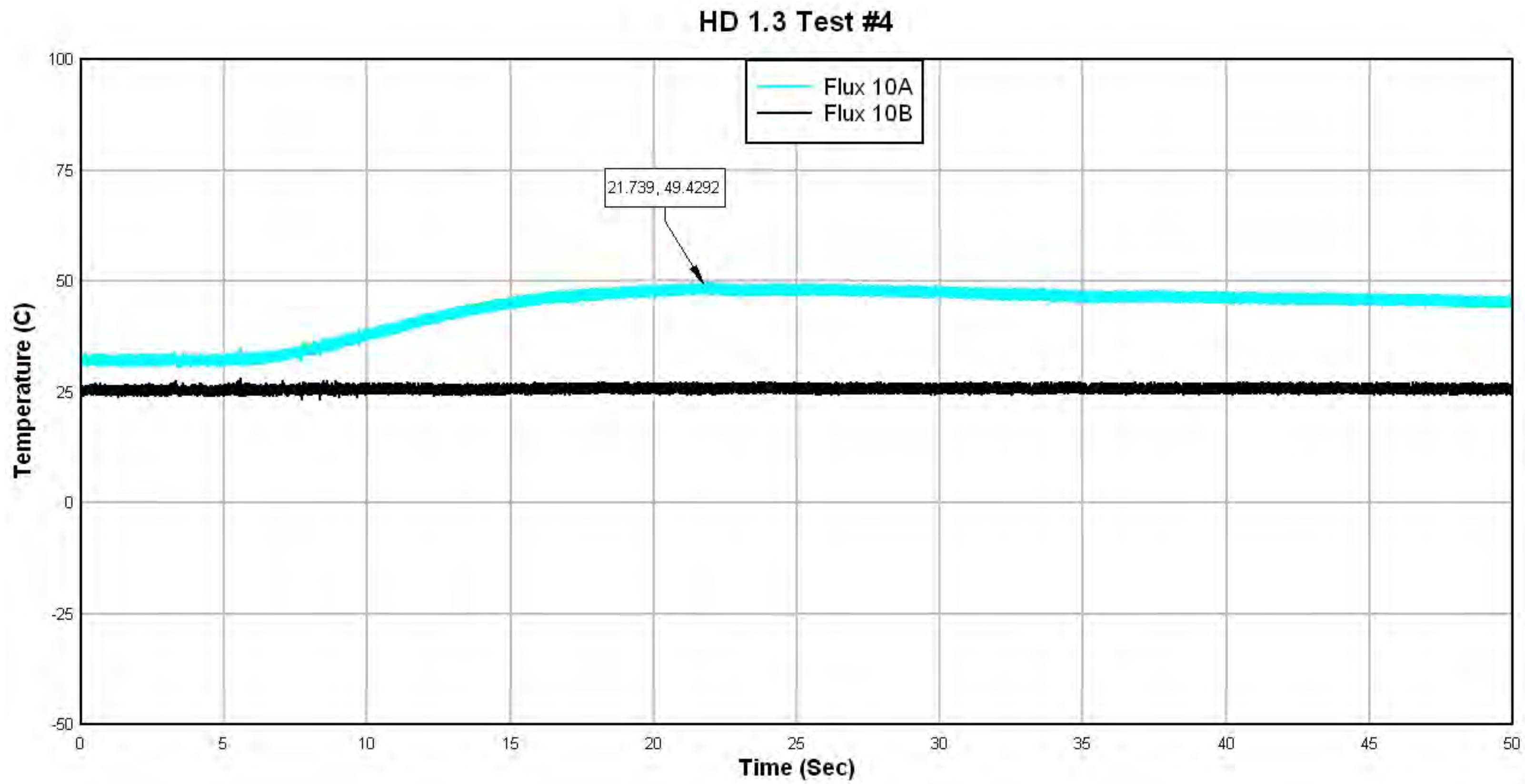

FIGURE V-B-33. Flux Gage #10A and 10B (Outside).

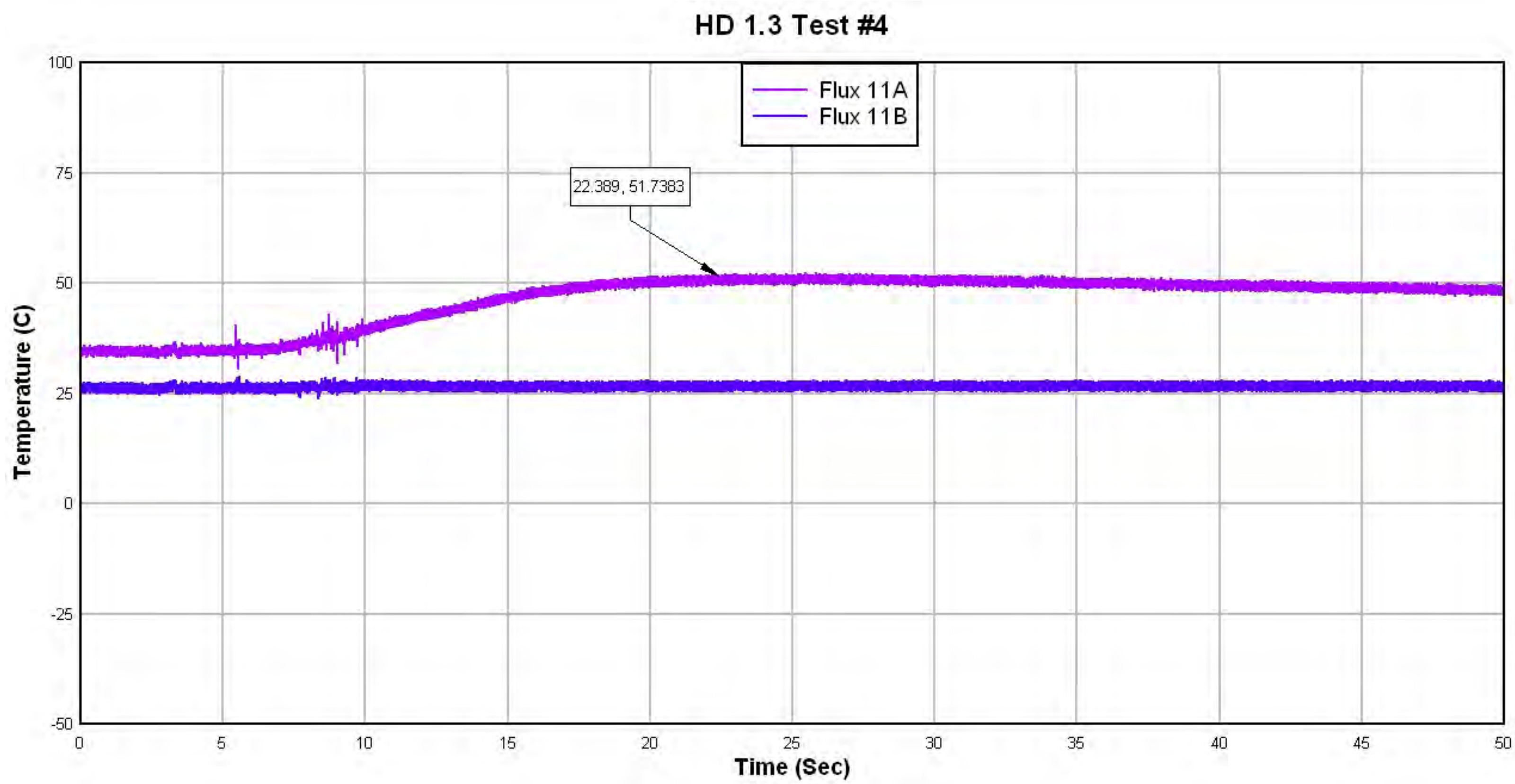

FIGURE V-B-34. Flux Gage #11A and 11B (Outside).

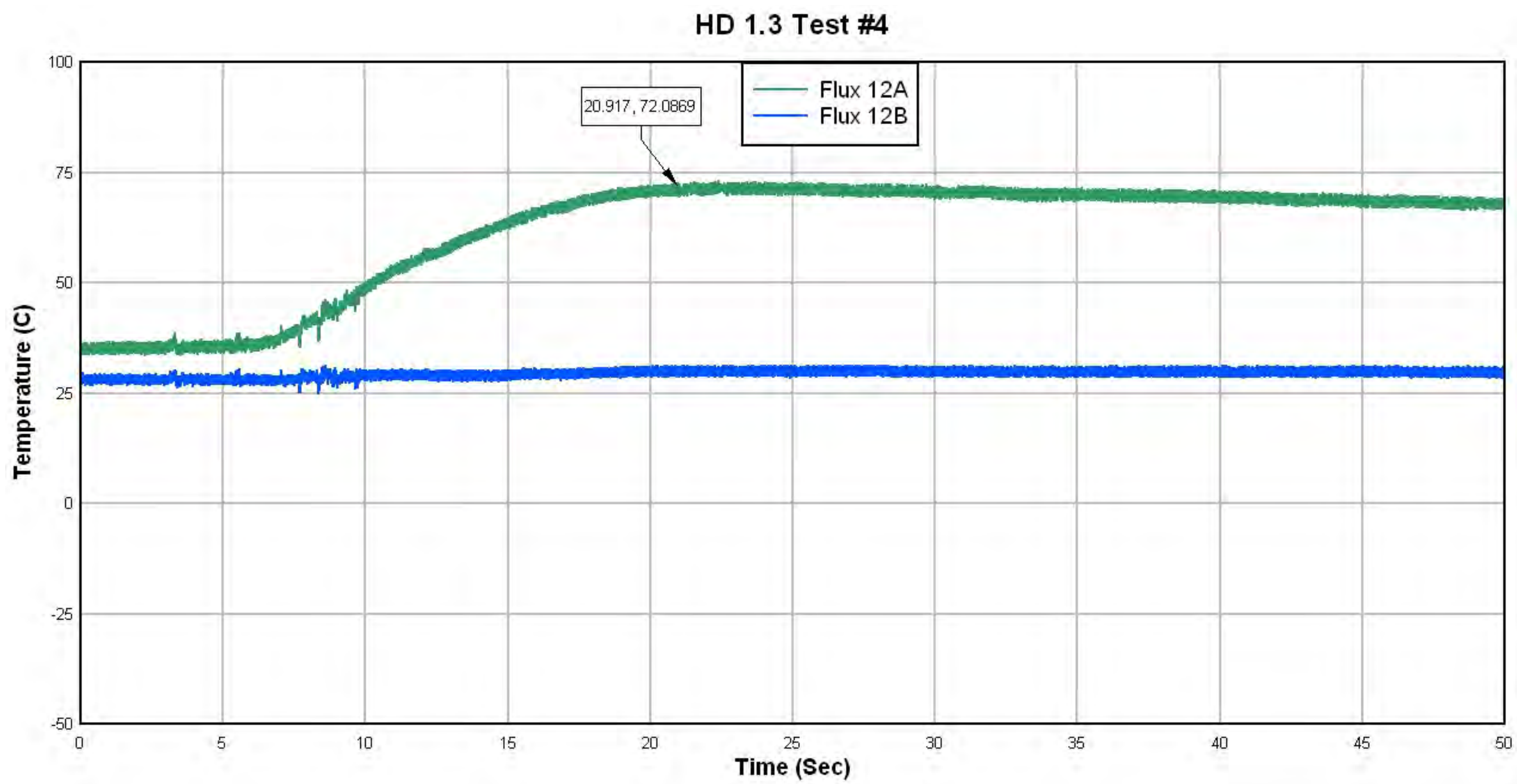

FIGURE V-B-35. Flux Gage #12A and 12B (Outside).

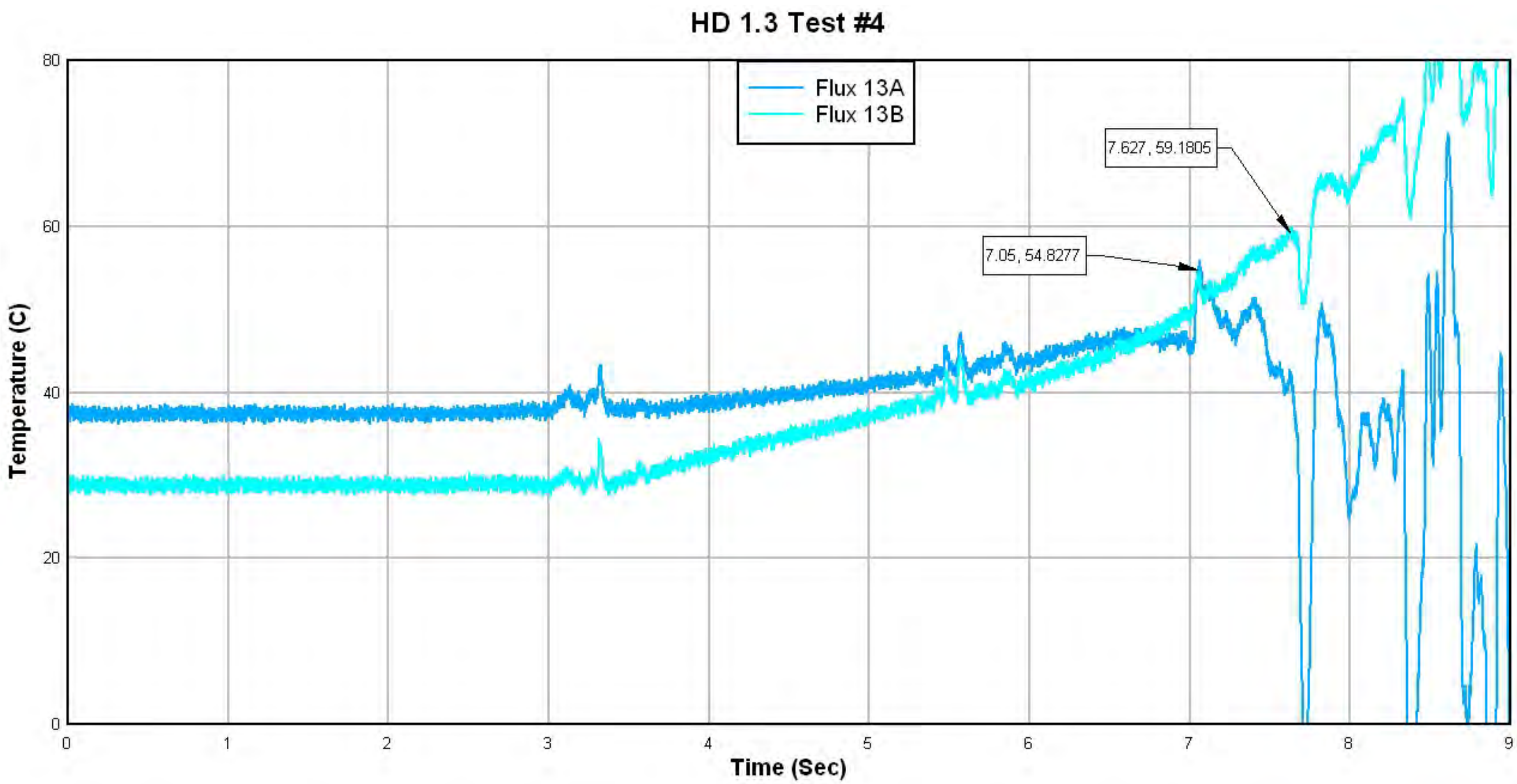

FIGURE V-B-36. Flux Gage #13A and 13B (Outside).

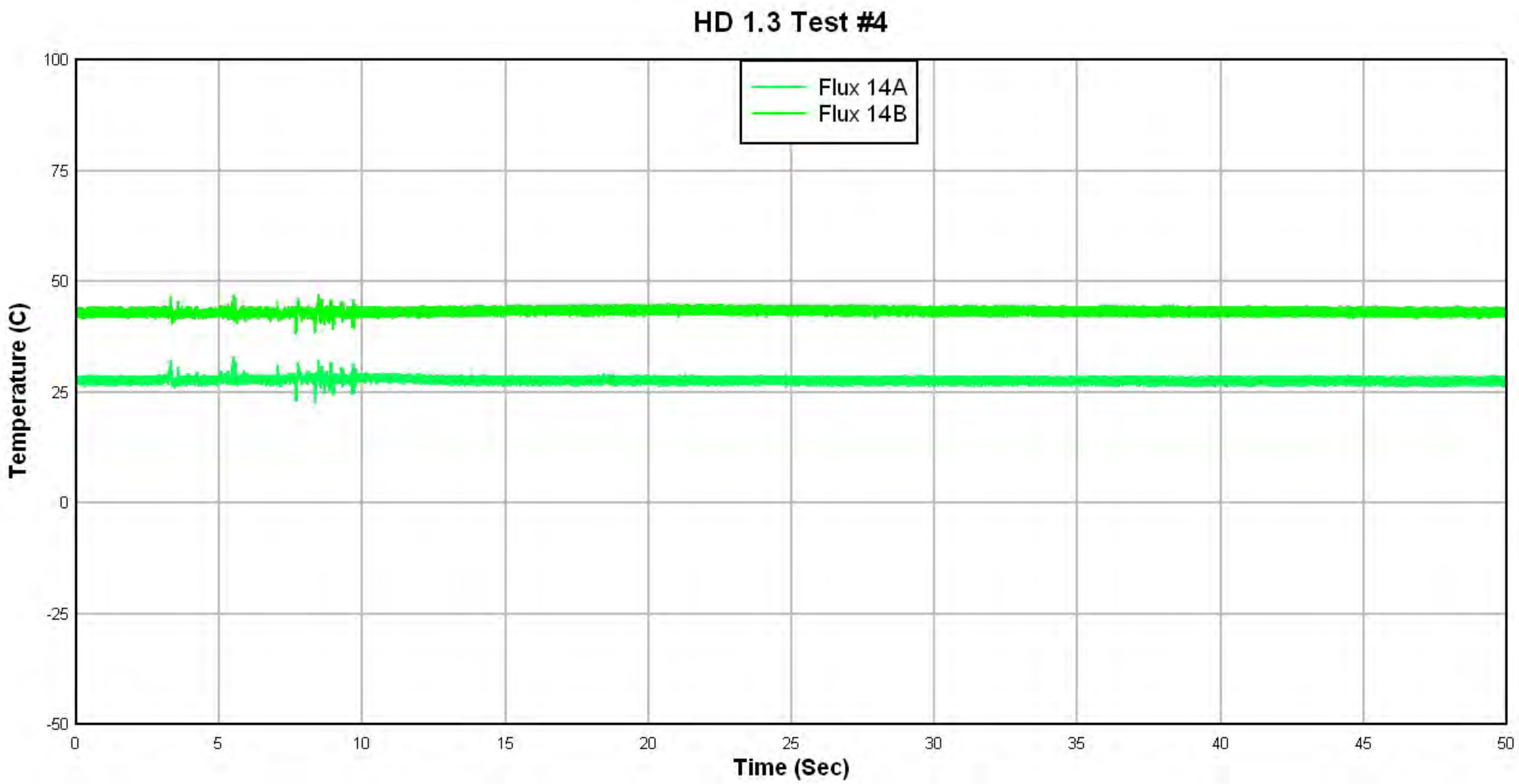

FIGURE V-B-37. Flux Gage #14A and 14B (Outside).

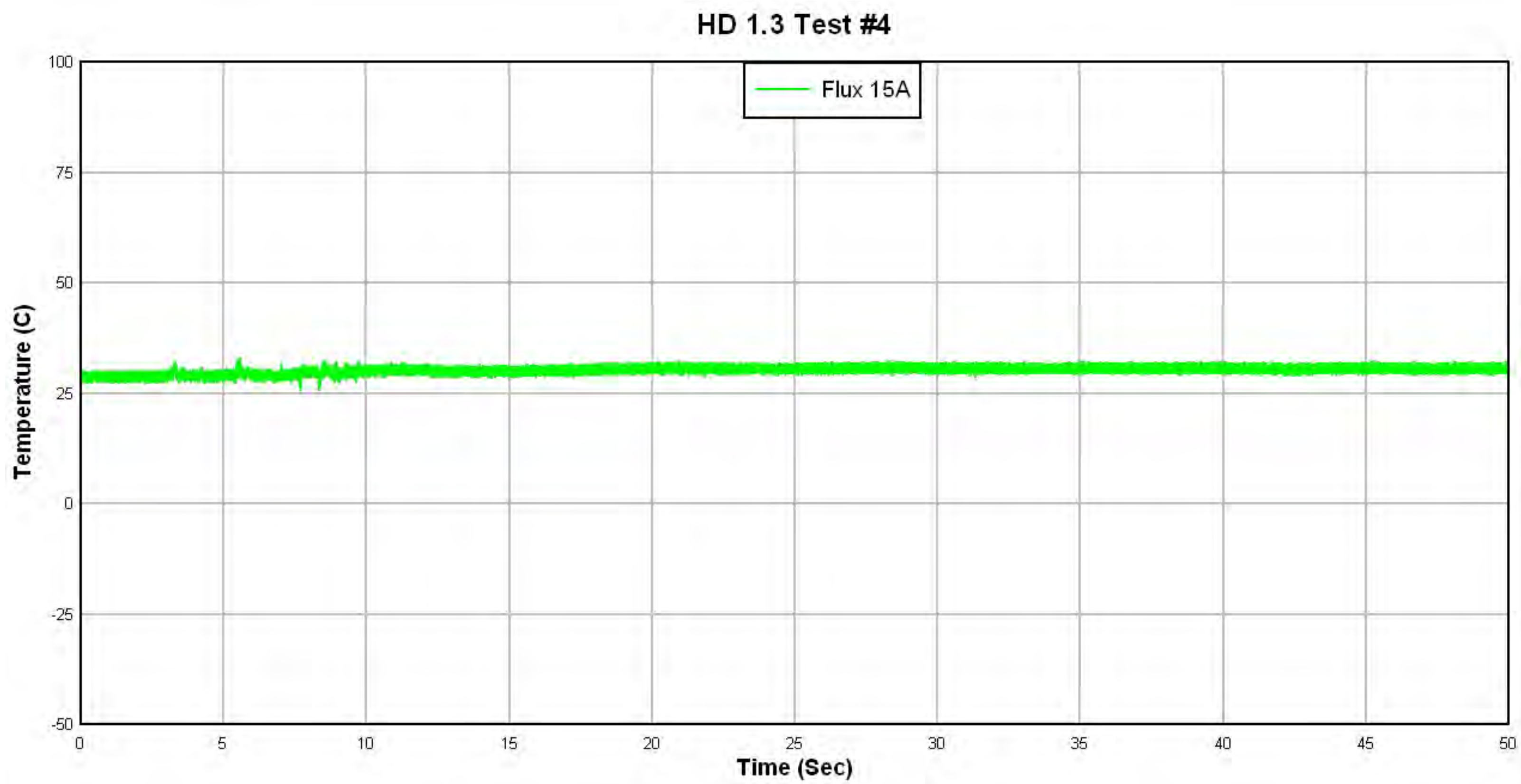

FIGURE V-B-38. Flux Gage #15A (Outside).

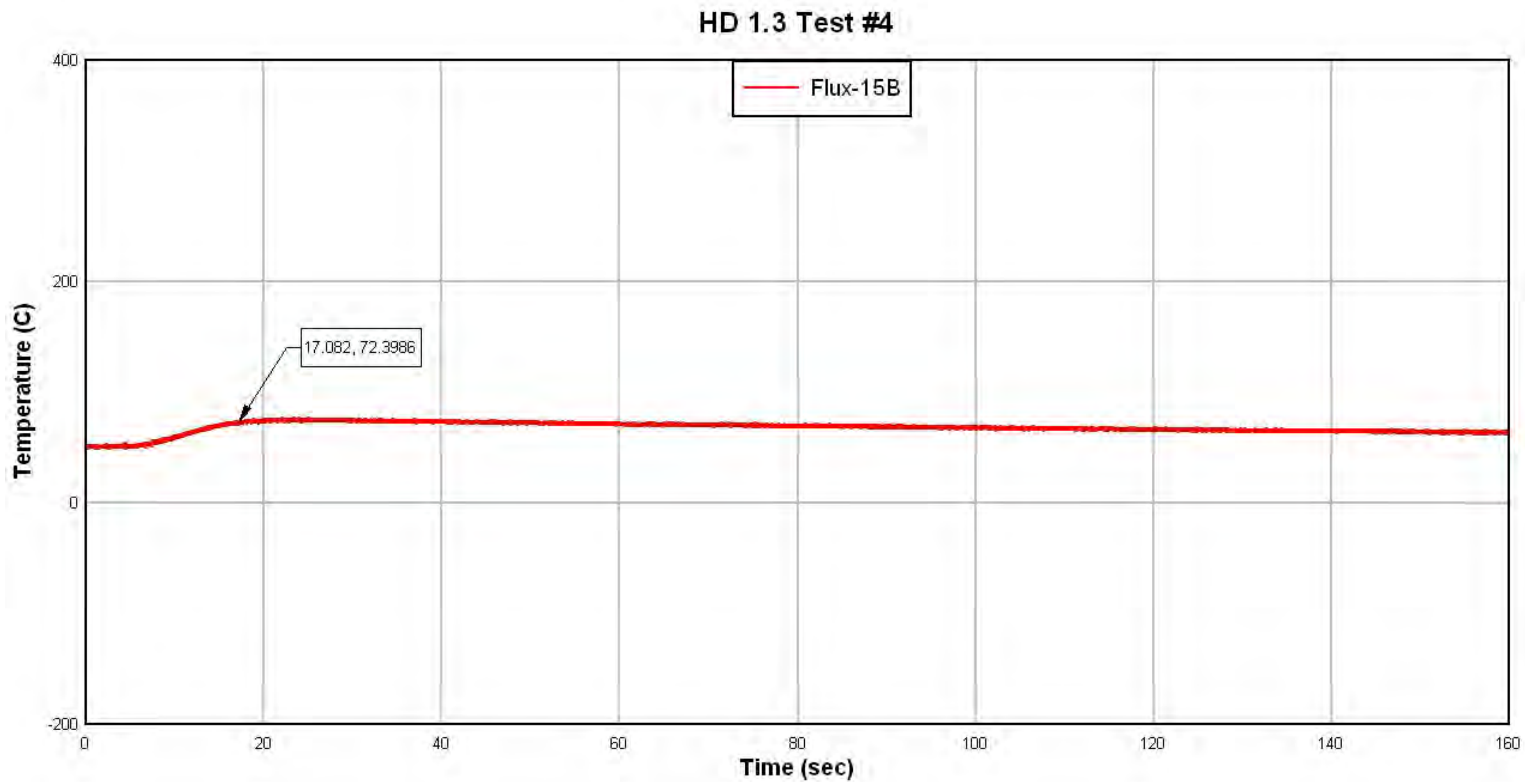

FIGURE V-B-39. Flux Gage #15B (Outside).

Summary

- Peak Temperatures Inside Structure
  - Thermocouple # 1 – 1116.18C at 11.14 sec
  - 485 C at 48.93 sec Flux Gage 16A
- Peak Temperatures Outside Structure
  - 101.45C at 35.19 sec Flux Gage 5A

Explanation of the Sensitivity study

- Based on the recording speed of the DAQ system the data was delaminated with an average of points that fit the sample rate of the gages
  - Providing a data point per second or 4 pts per second
  - Difference in the magnitude and location of the plots was minimal.
  - Decided to use cleanest plot for each DFT measurement

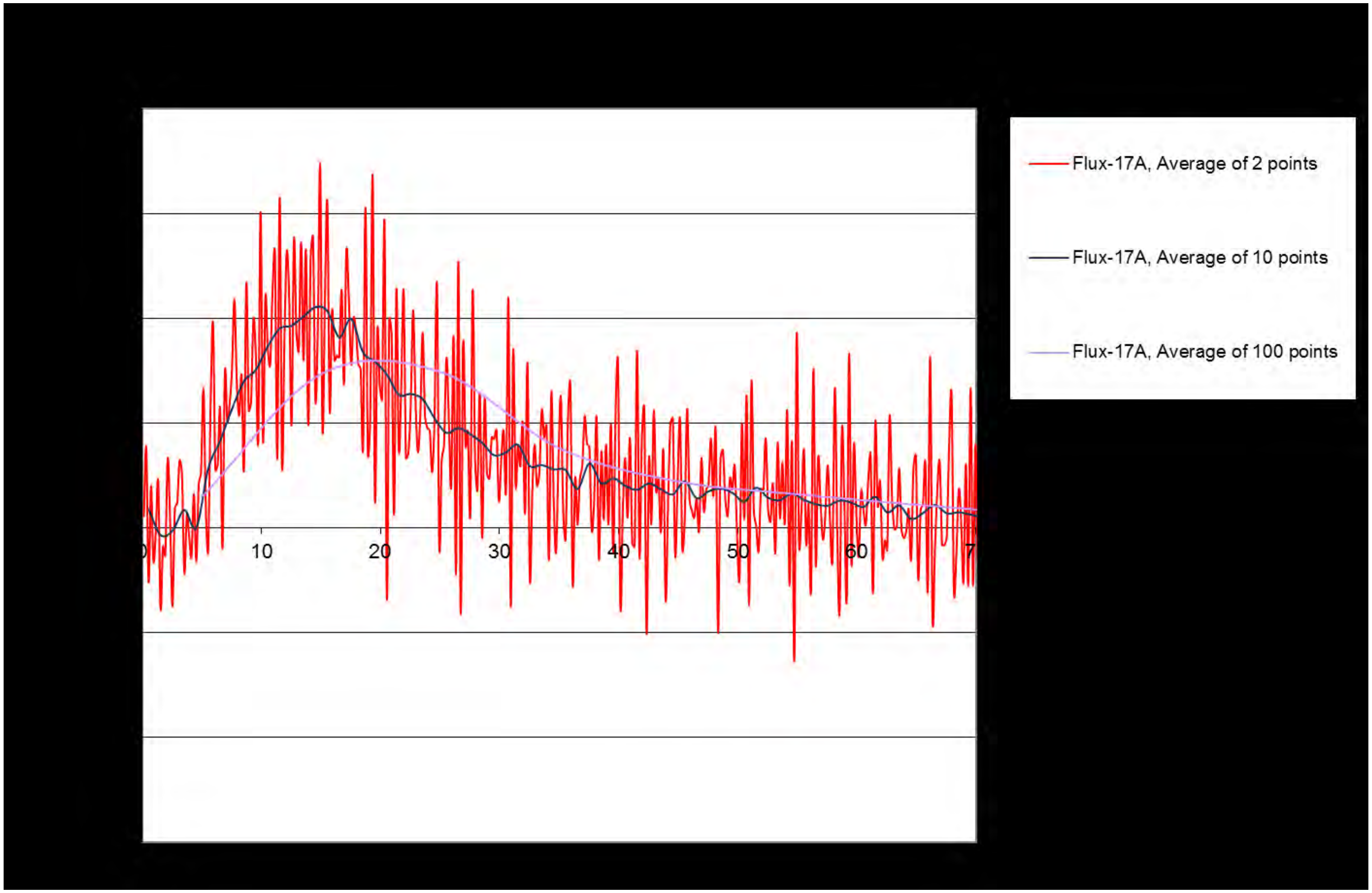

FIGURE V-B-40. Example: Sensitivity Study.

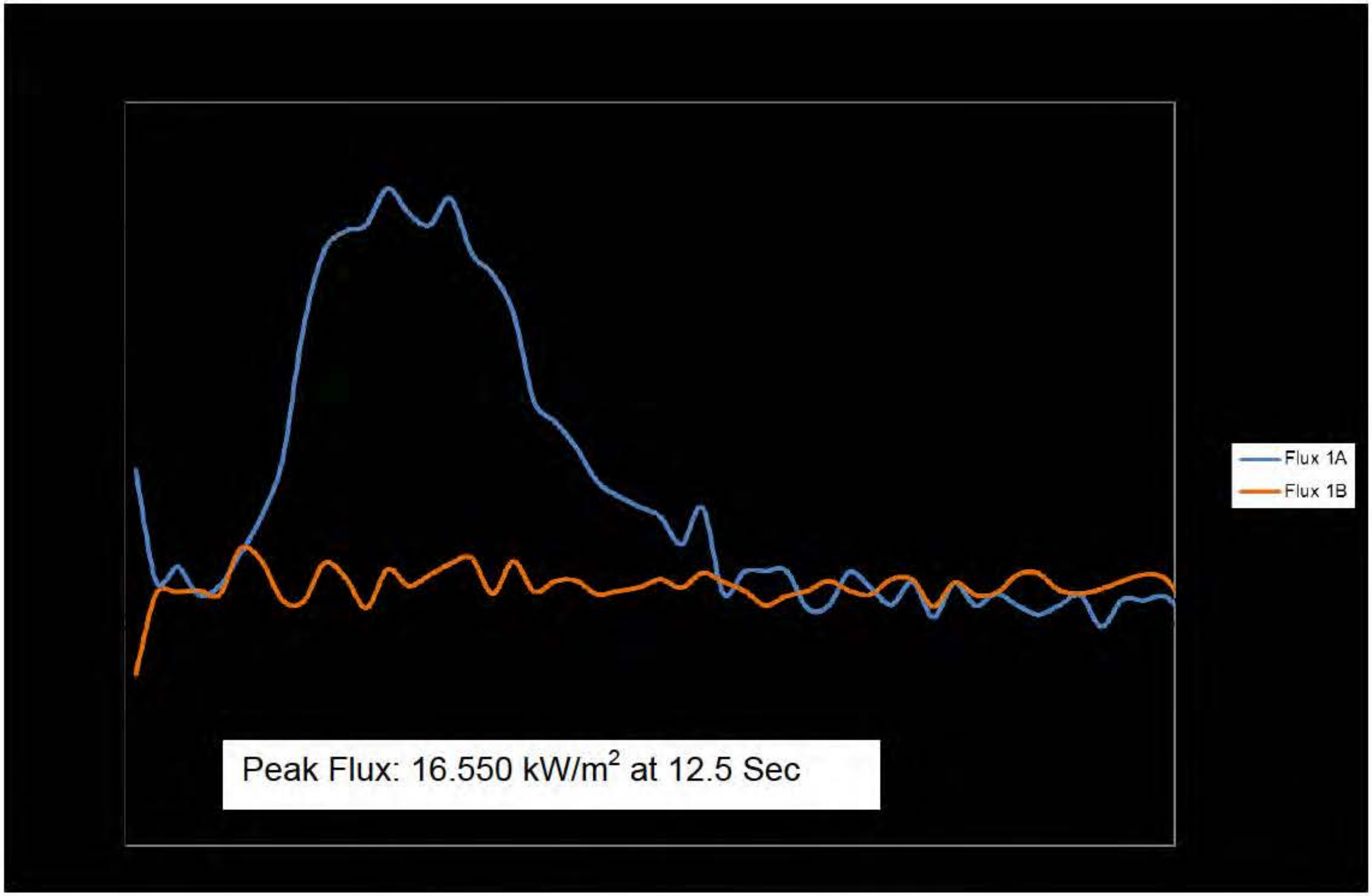

FIGURE V-B-41. Heat Flux Gages #1A and 1B.

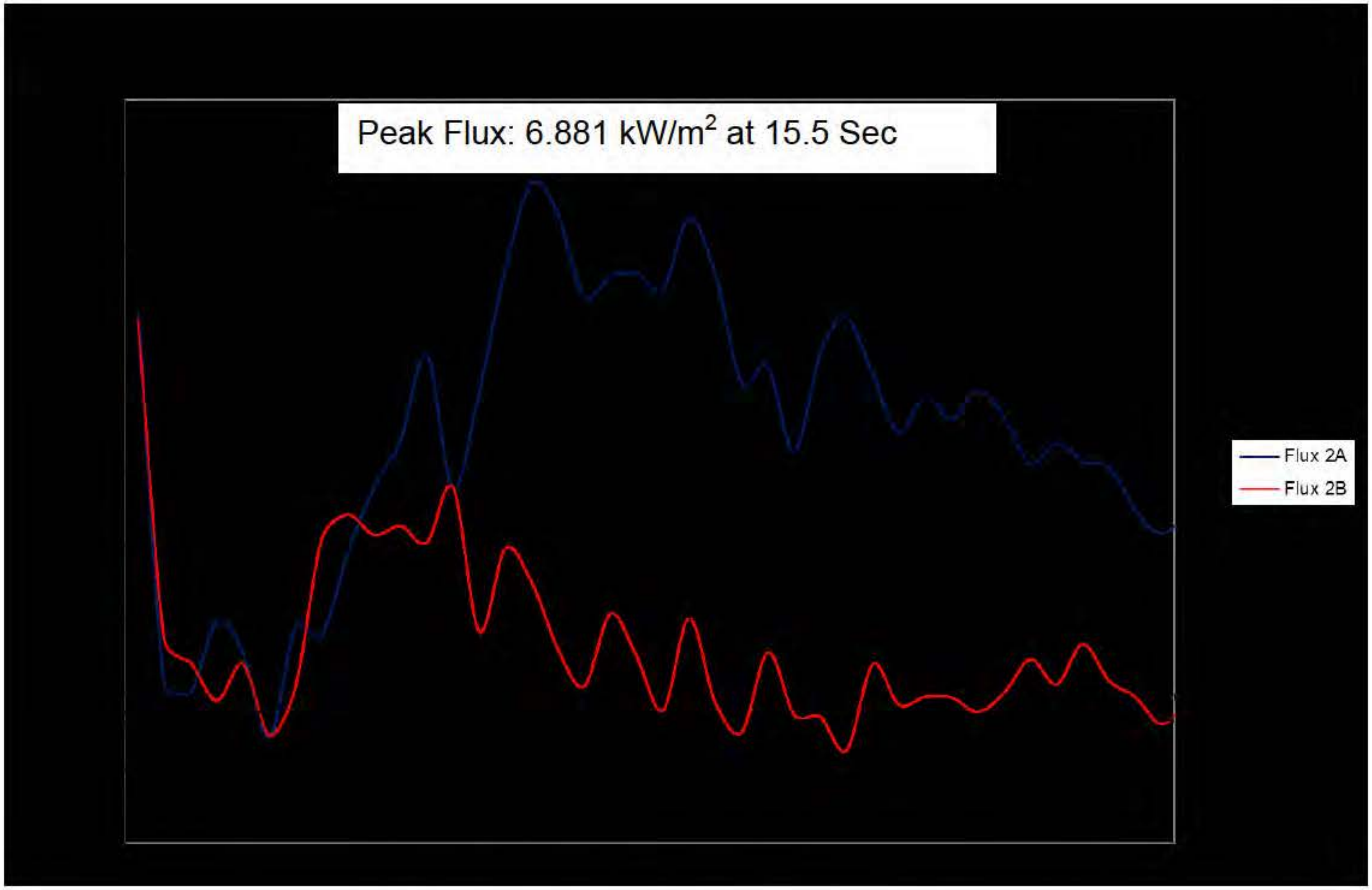

FIGURE V-B-42. Heat Flux Gages #2A and 2B.

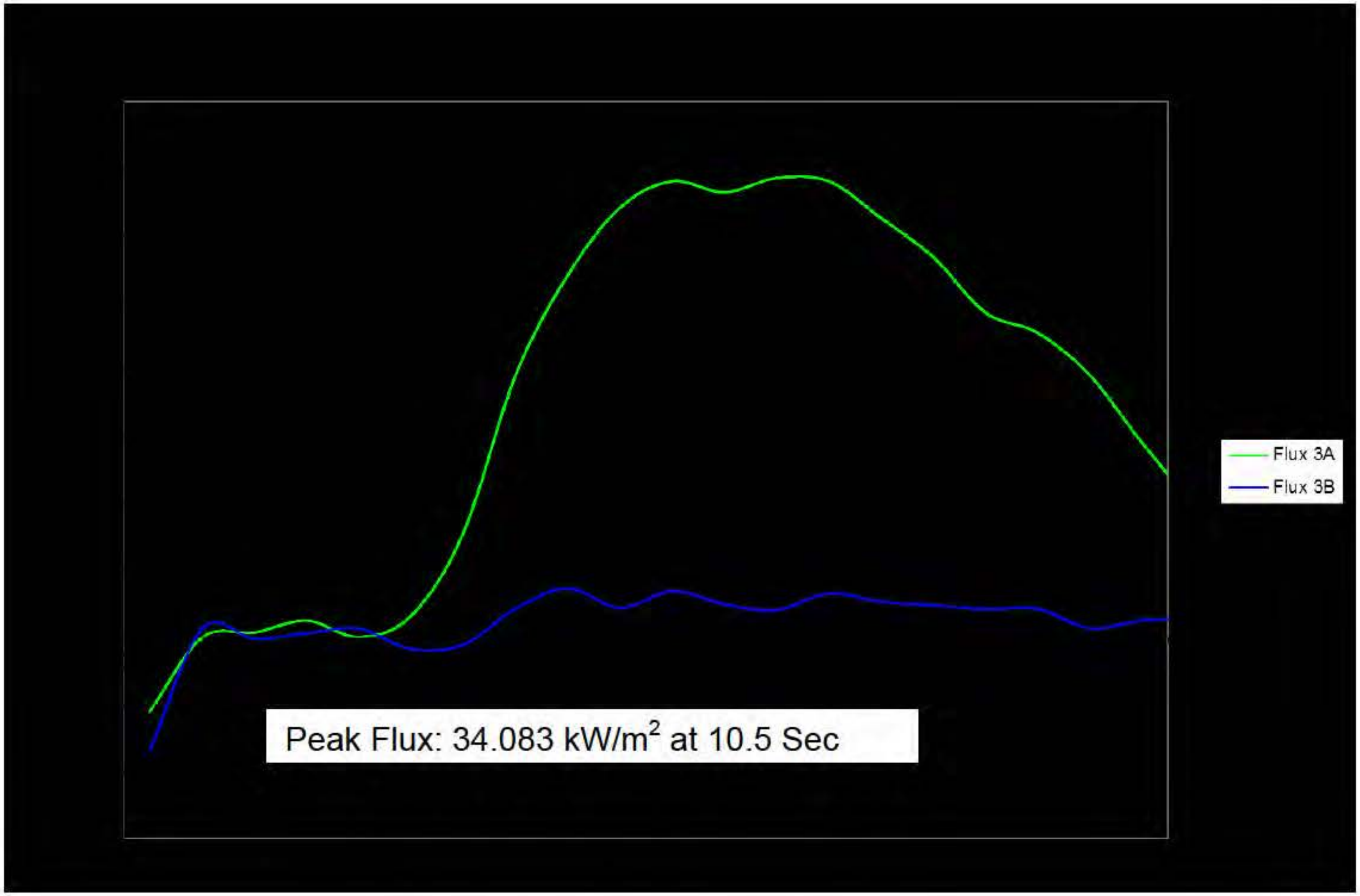

FIGURE V-B-43. Heat Flux Gages #3A and 3B.

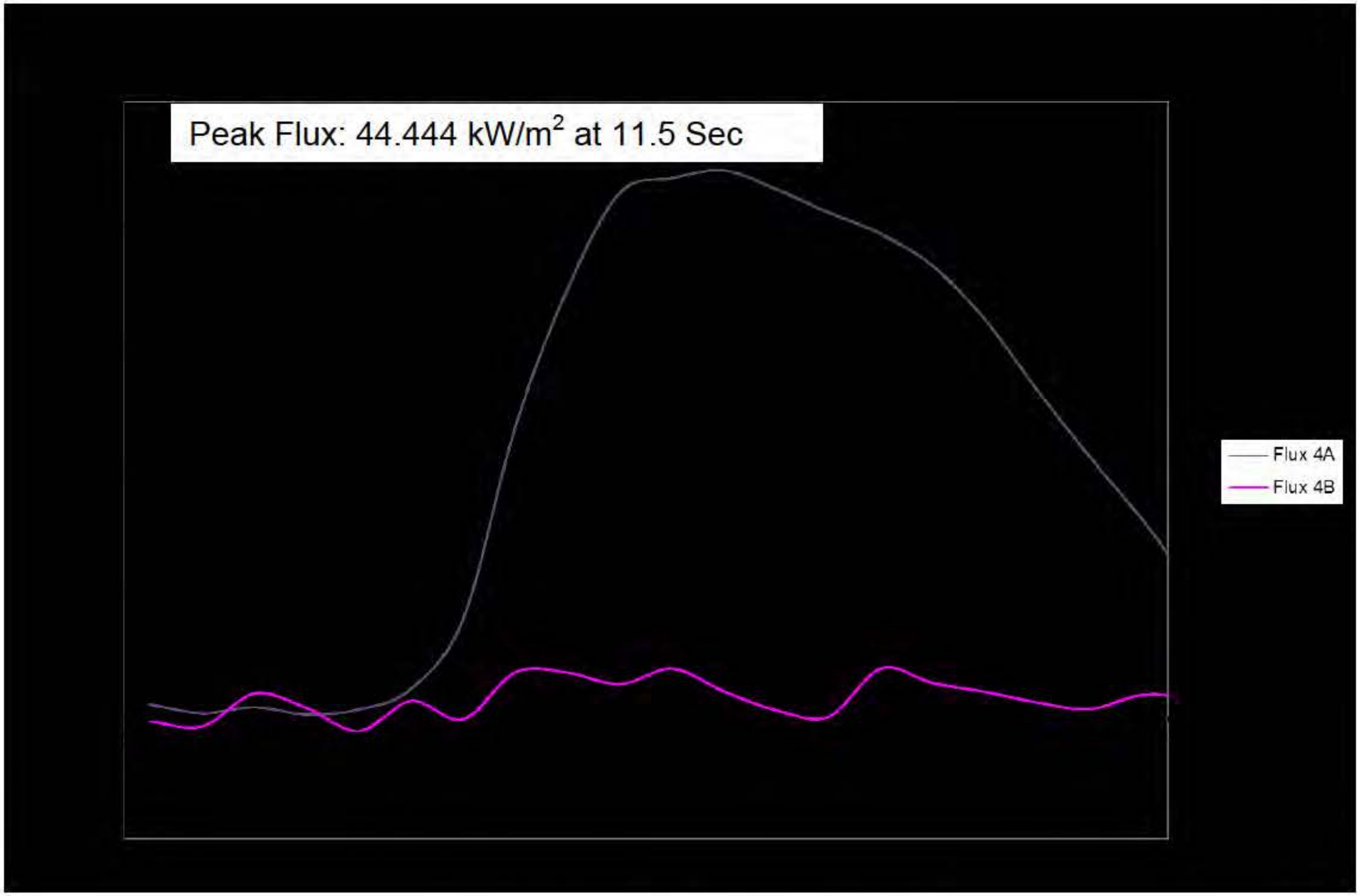

FIGURE V-B-44. Heat Flux Gages #4A and 4B.

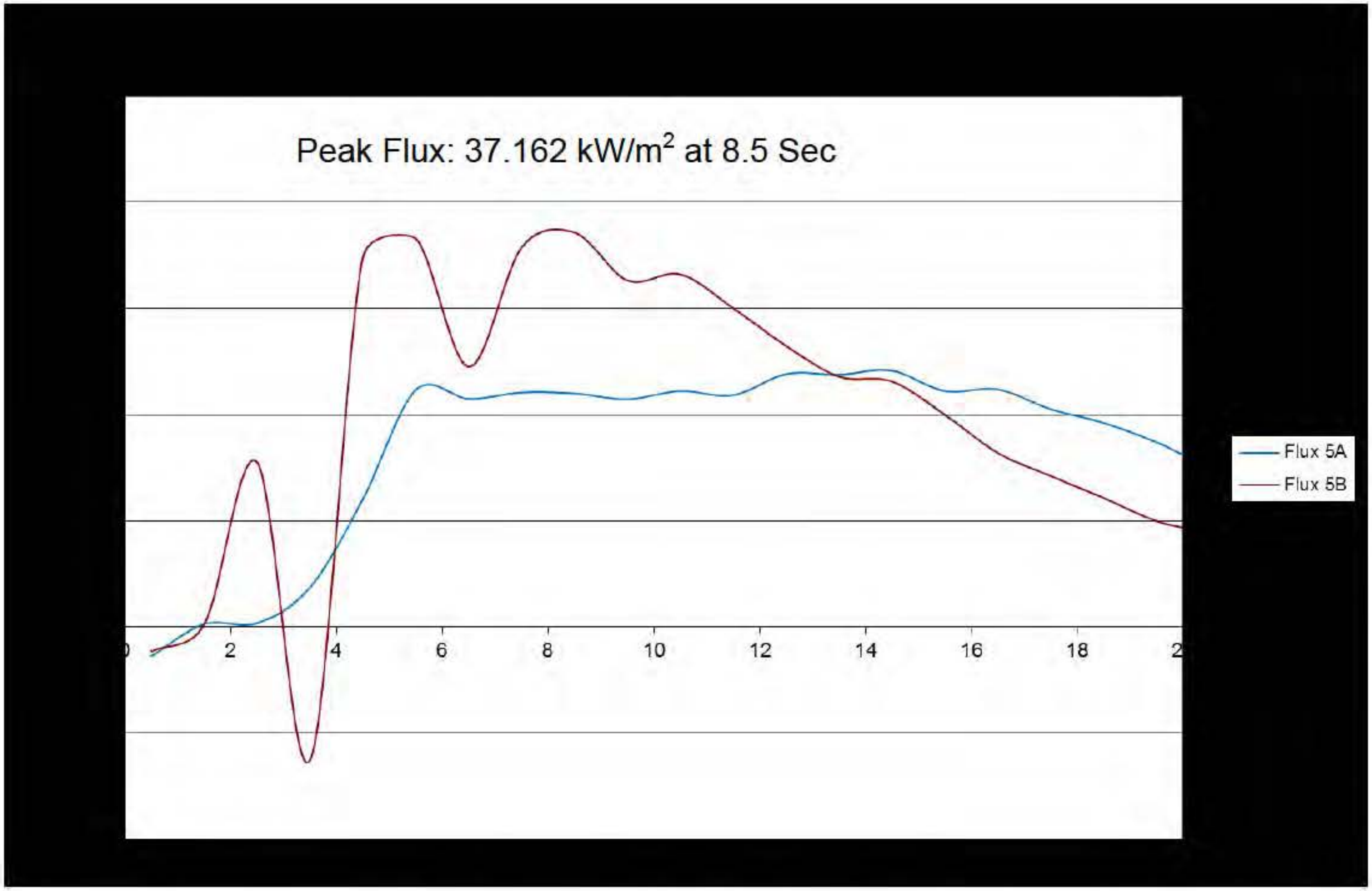

FIGURE V-B-45. Heat Flux Gages #5A and 5B.

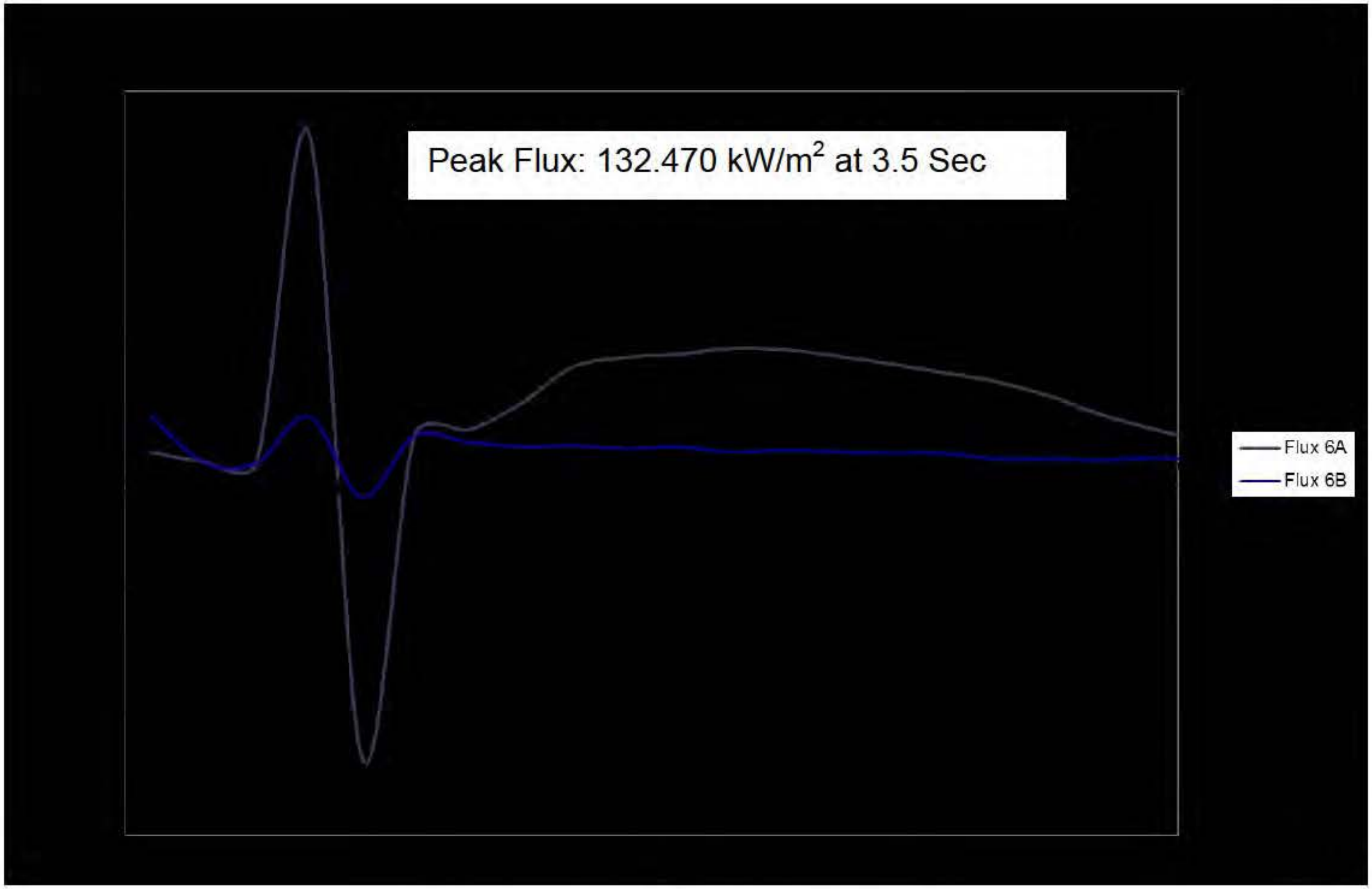

FIGURE V-B-46. Heat Flux Gages #6A and 6B.

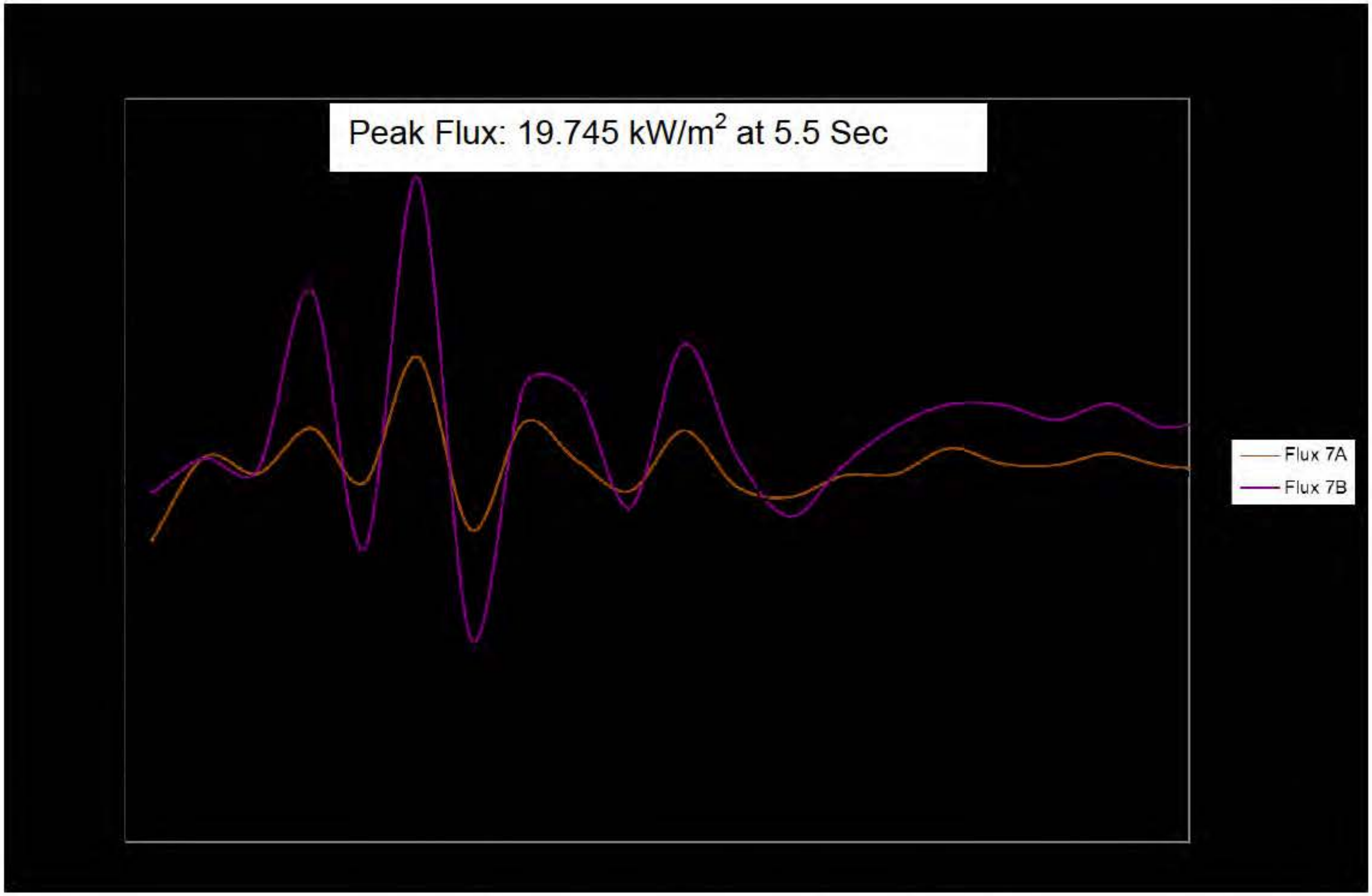

FIGURE V-B-47. Heat Flux Gages #7A and 7B.

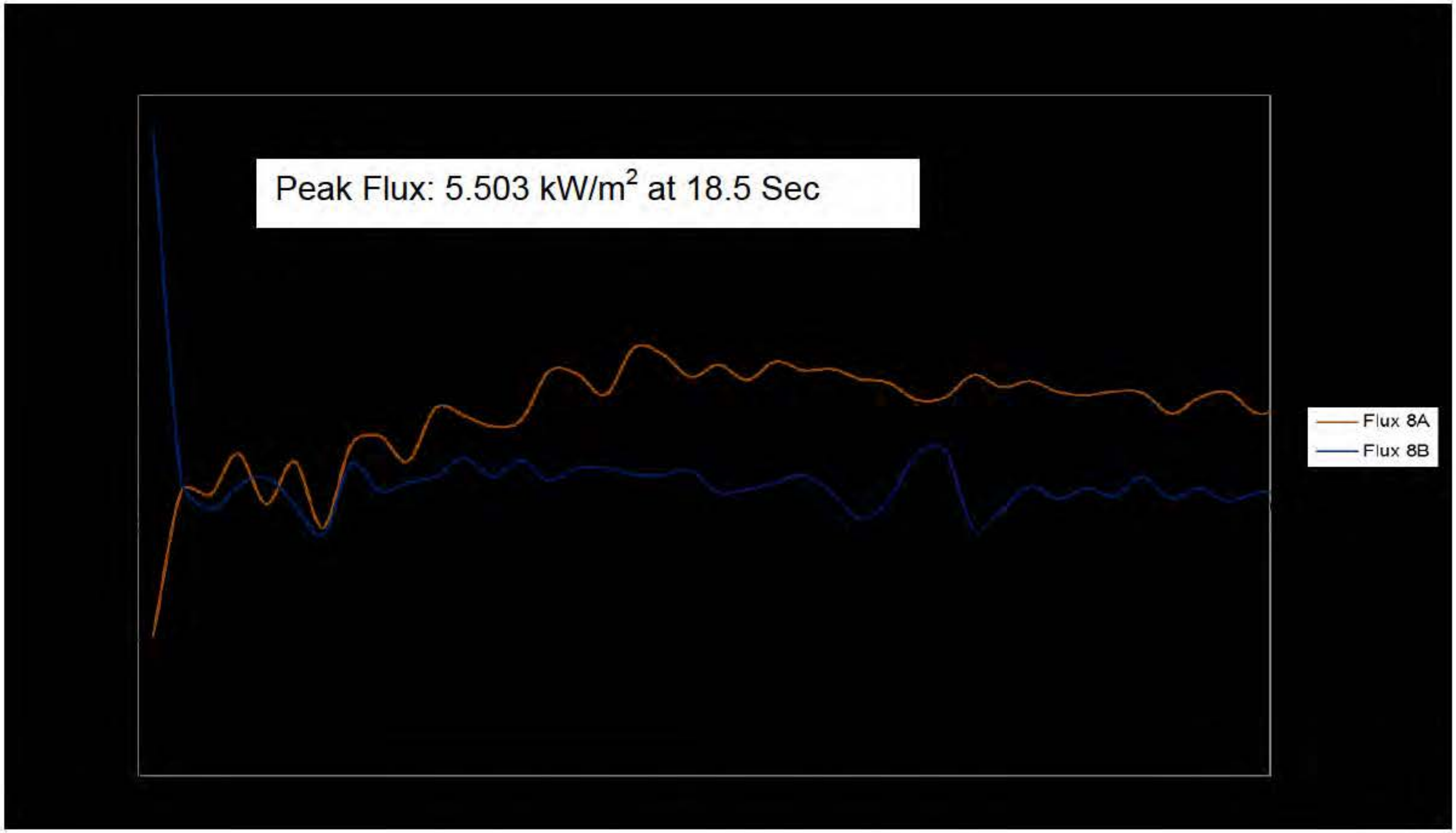

FIGURE V-B-48. Heat Flux Gages #8A and 8B.

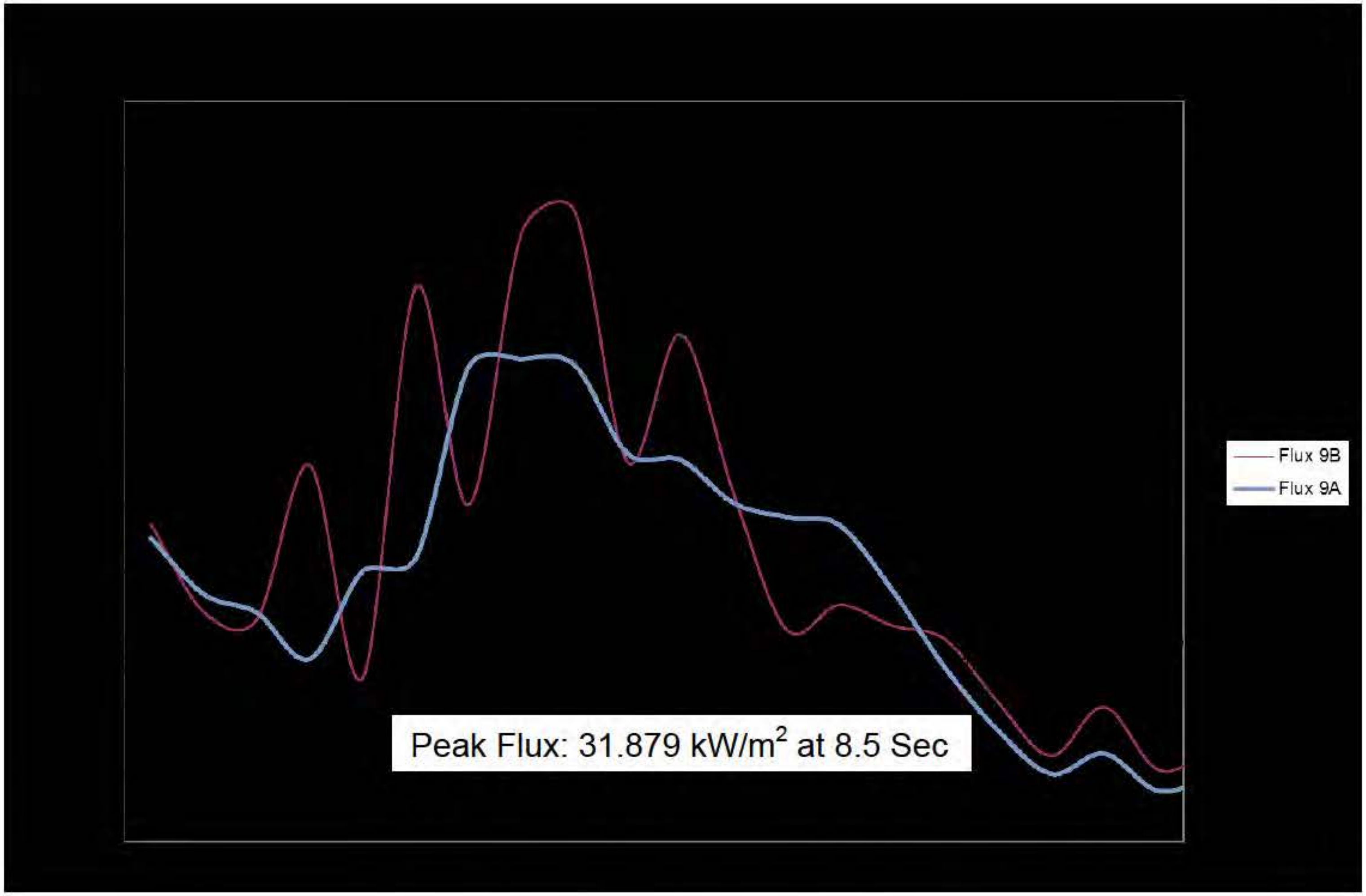

FIGURE V-B-49. Heat Flux Gages #9A and 9B.

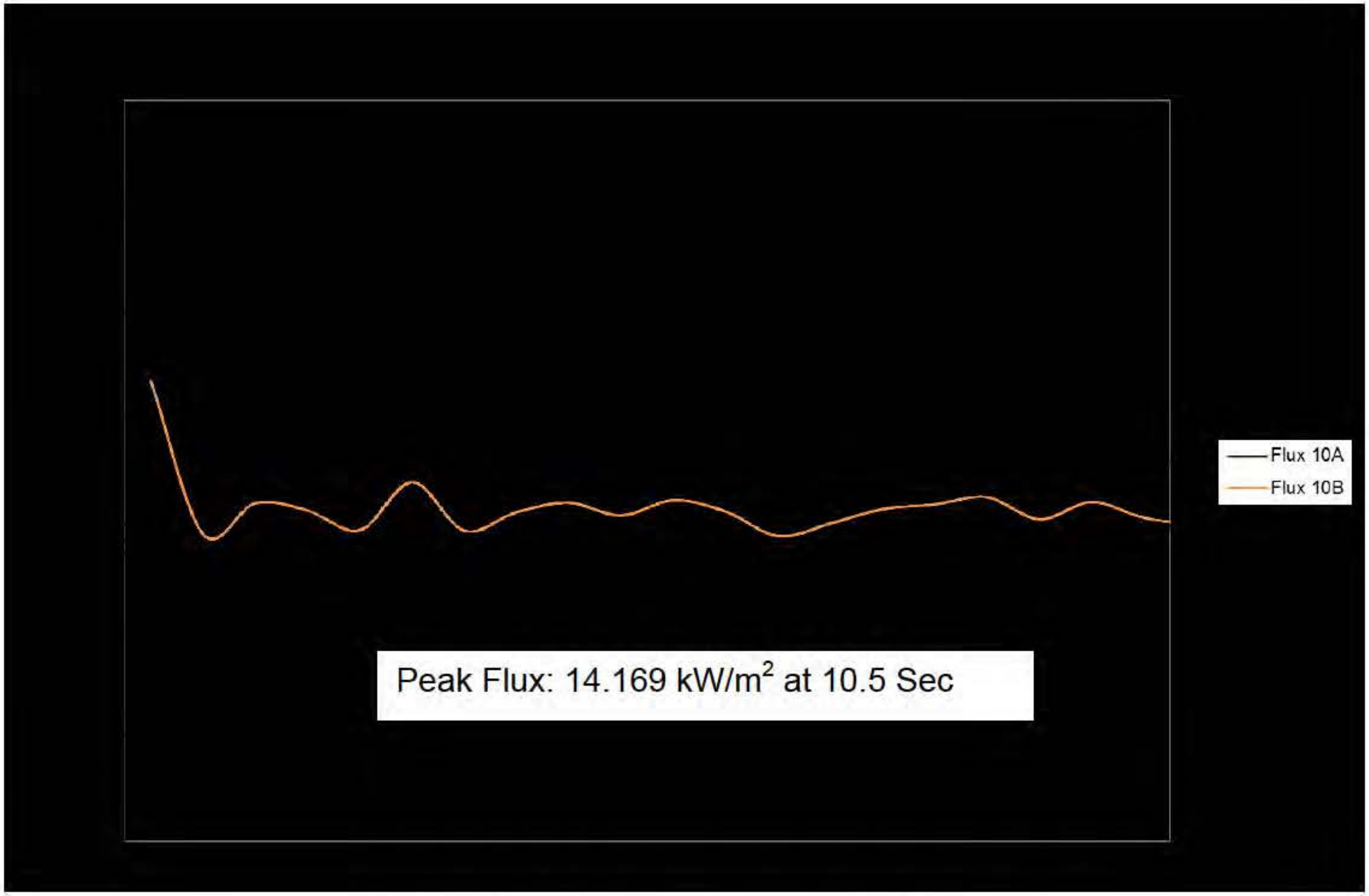

FIGURE V-B-50. Heat Flux Gages #10A and 10B.

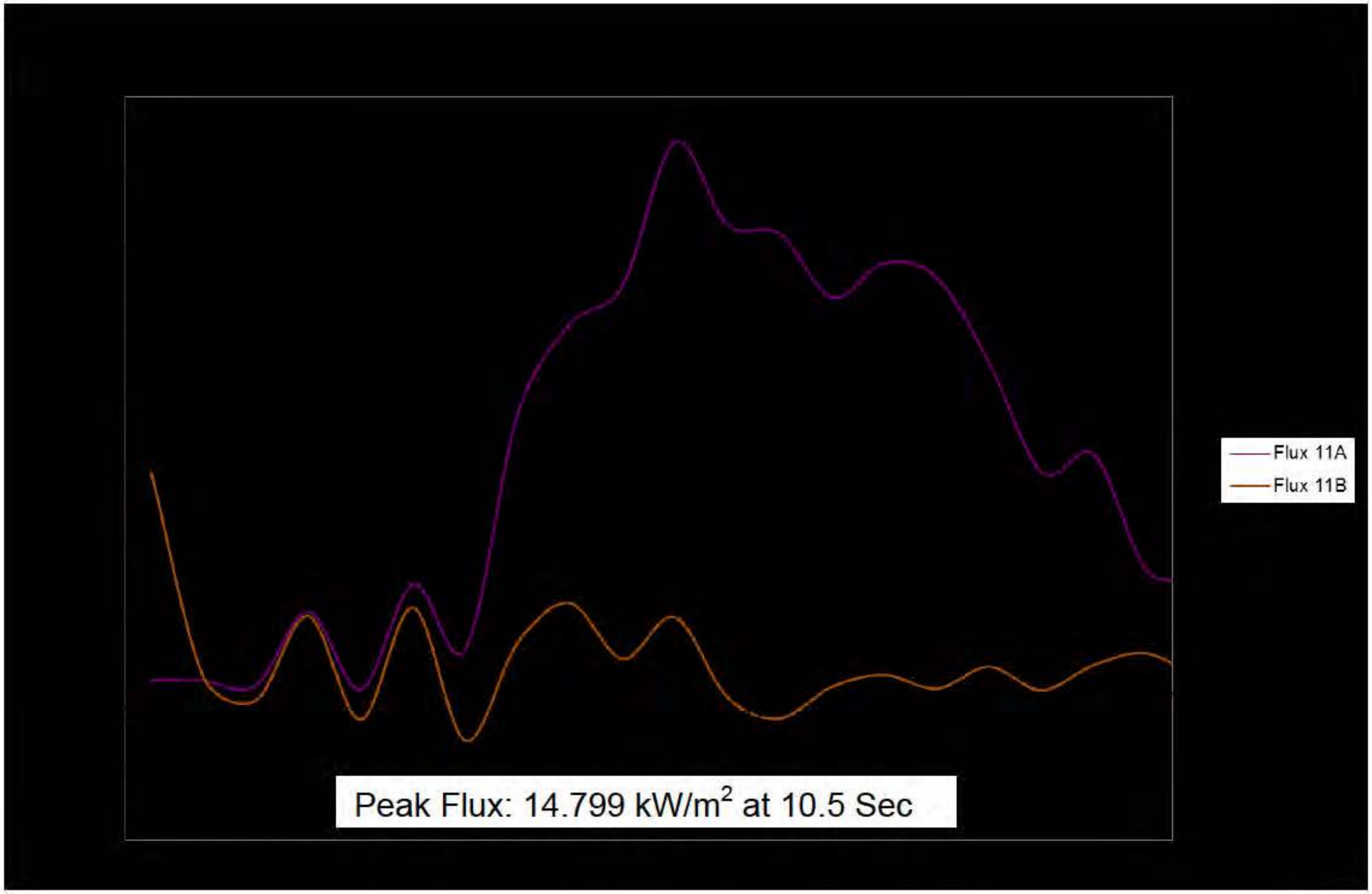

FIGURE V-B-51. Heat Flux Gages #11A and 11B.

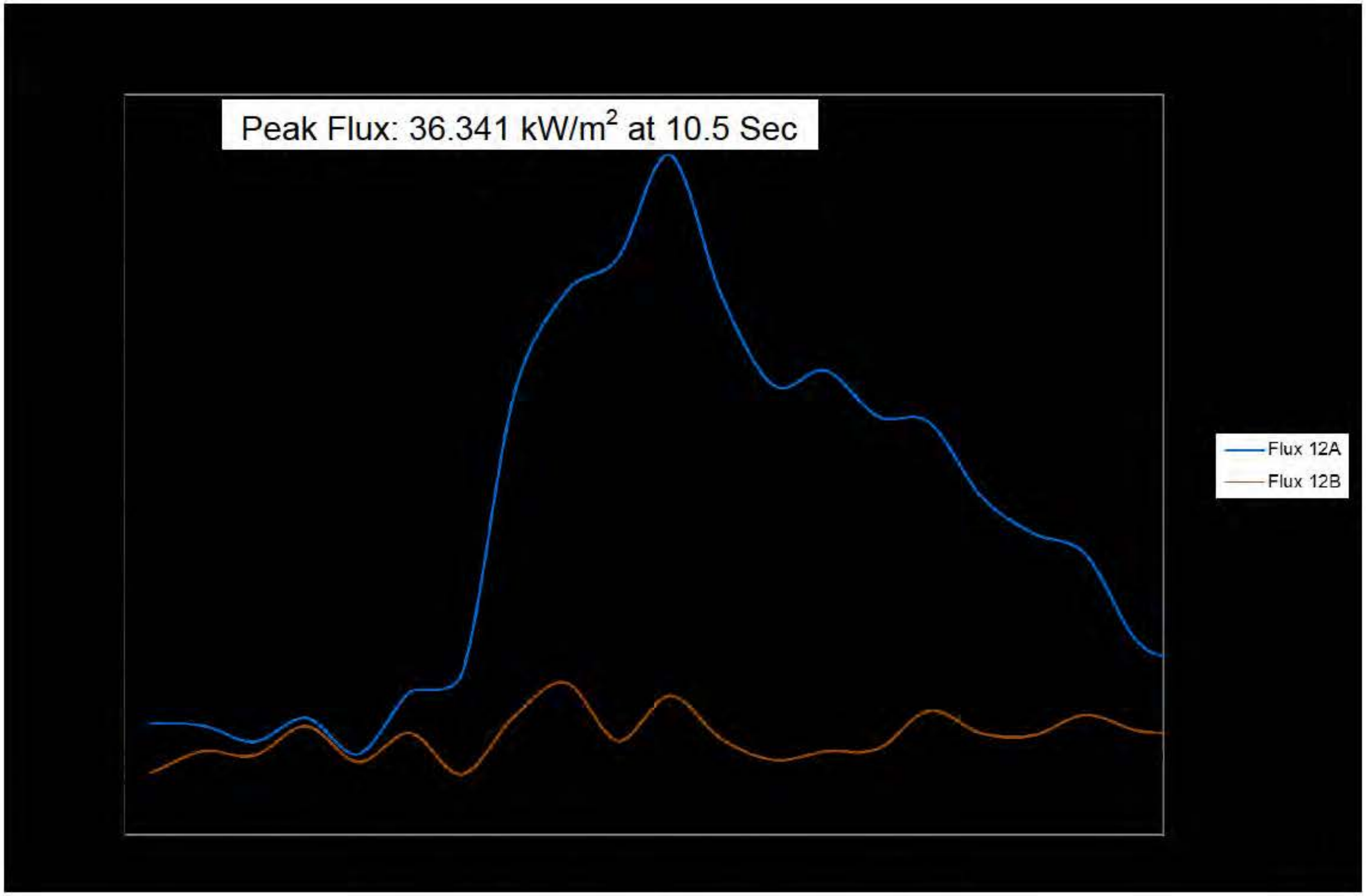

FIGURE V-B-52. Heat Flux Gages #12A and 12B.

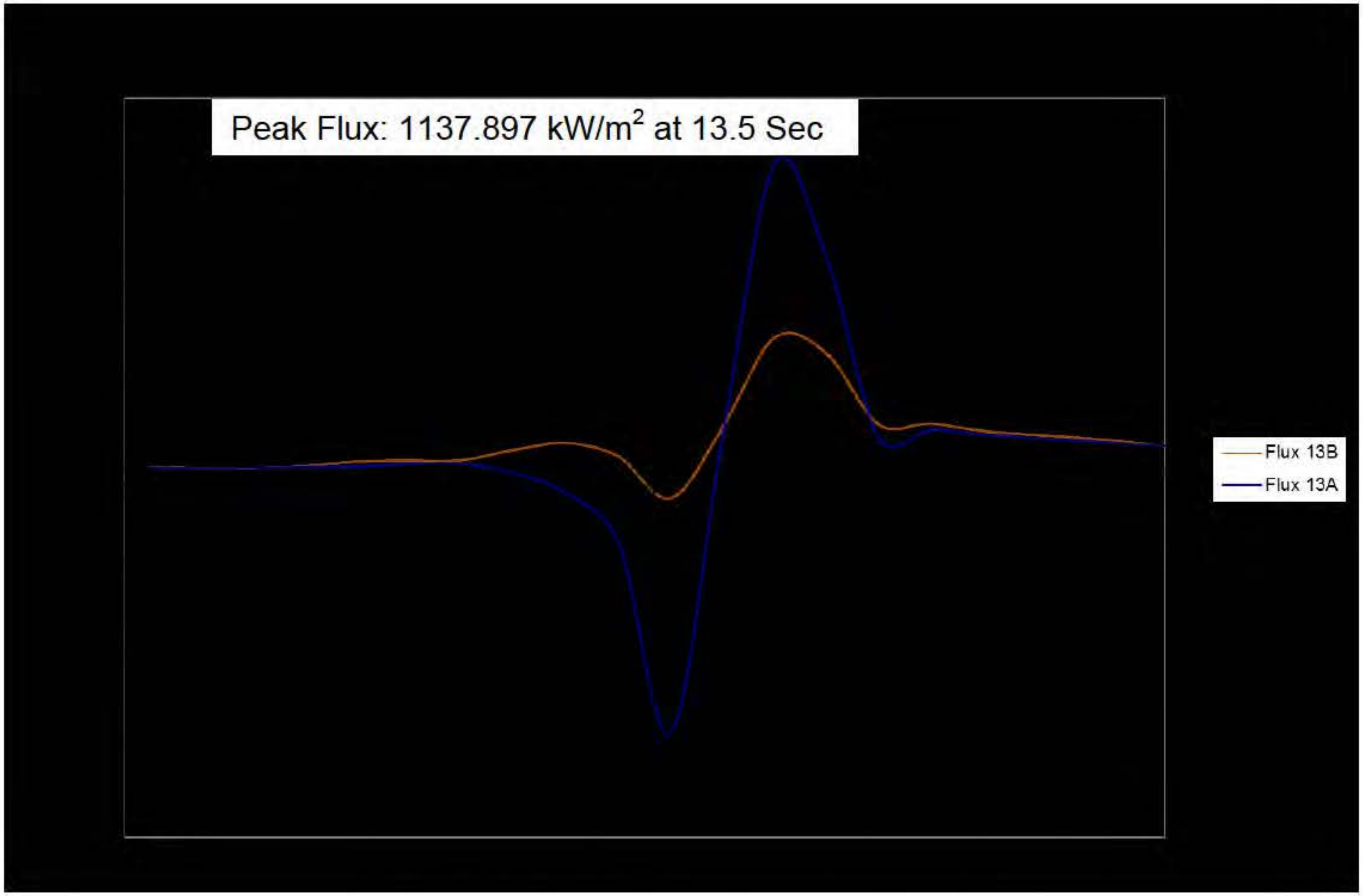

FIGURE V-B-53. Heat Flux Gages #13A and 13B.

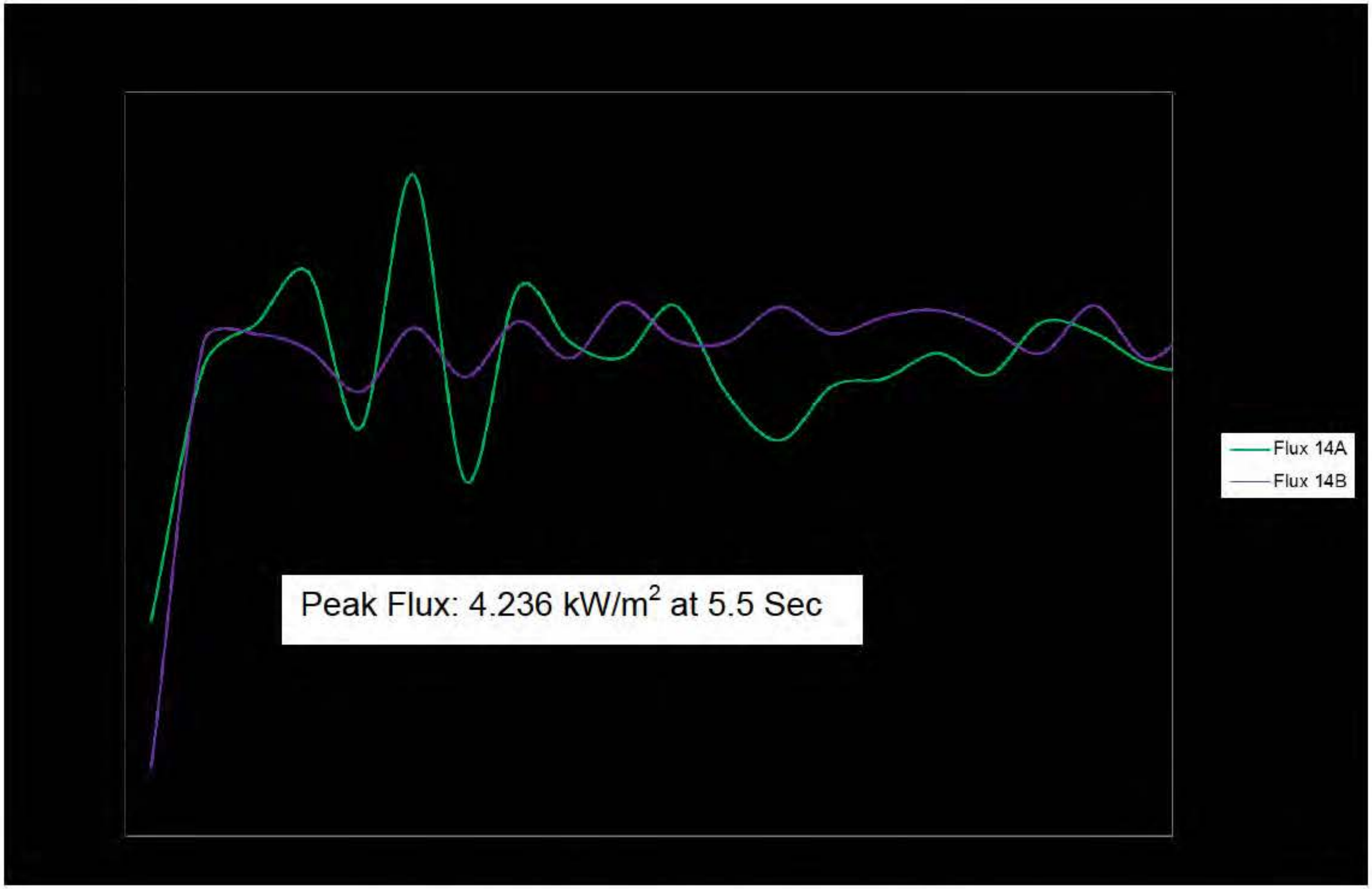

FIGURE V-B-54. Heat Flux Gages #14A and 14B.

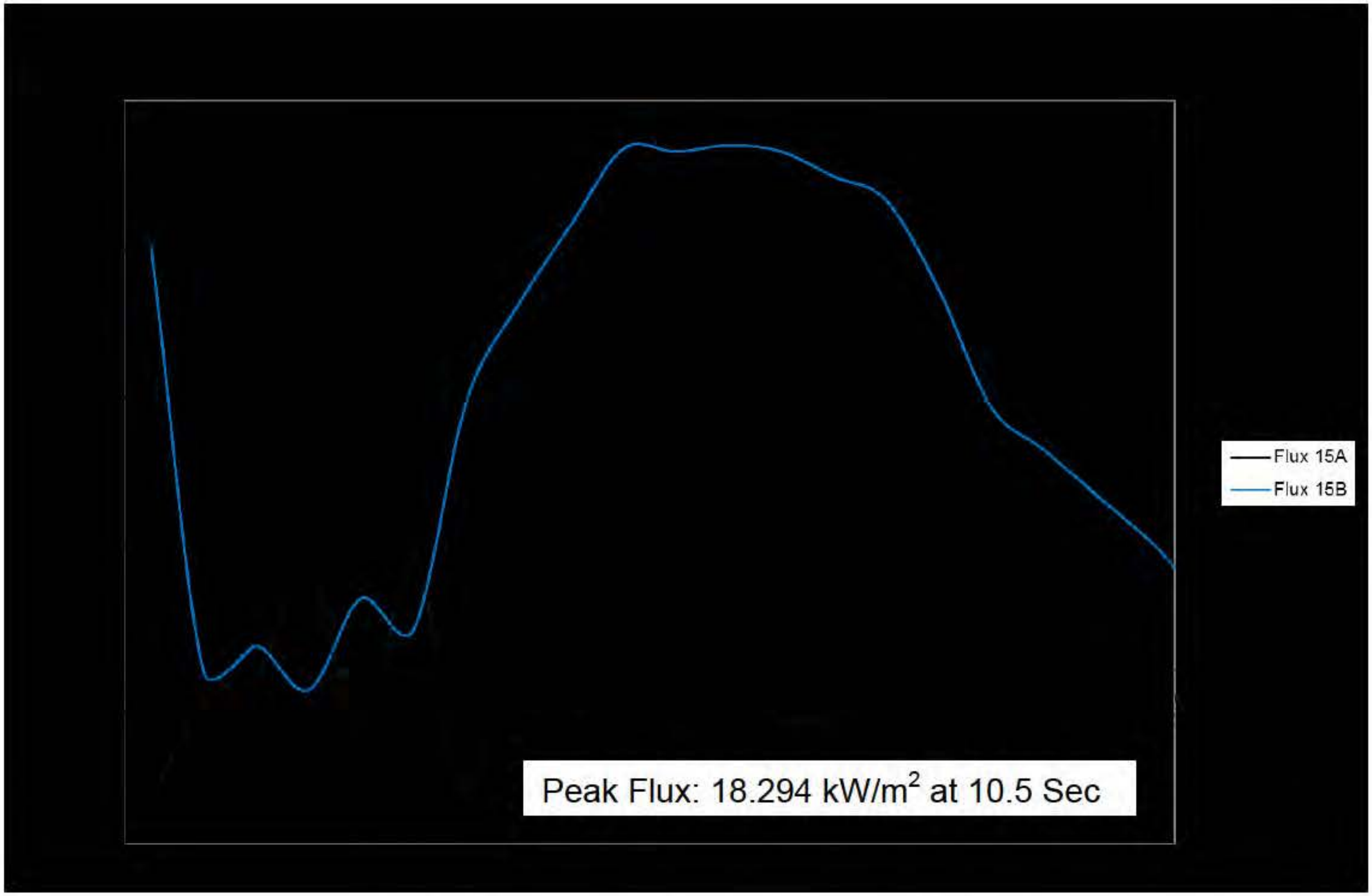

FIGURE V-B-55. Heat Flux Gages #15A and 15B.

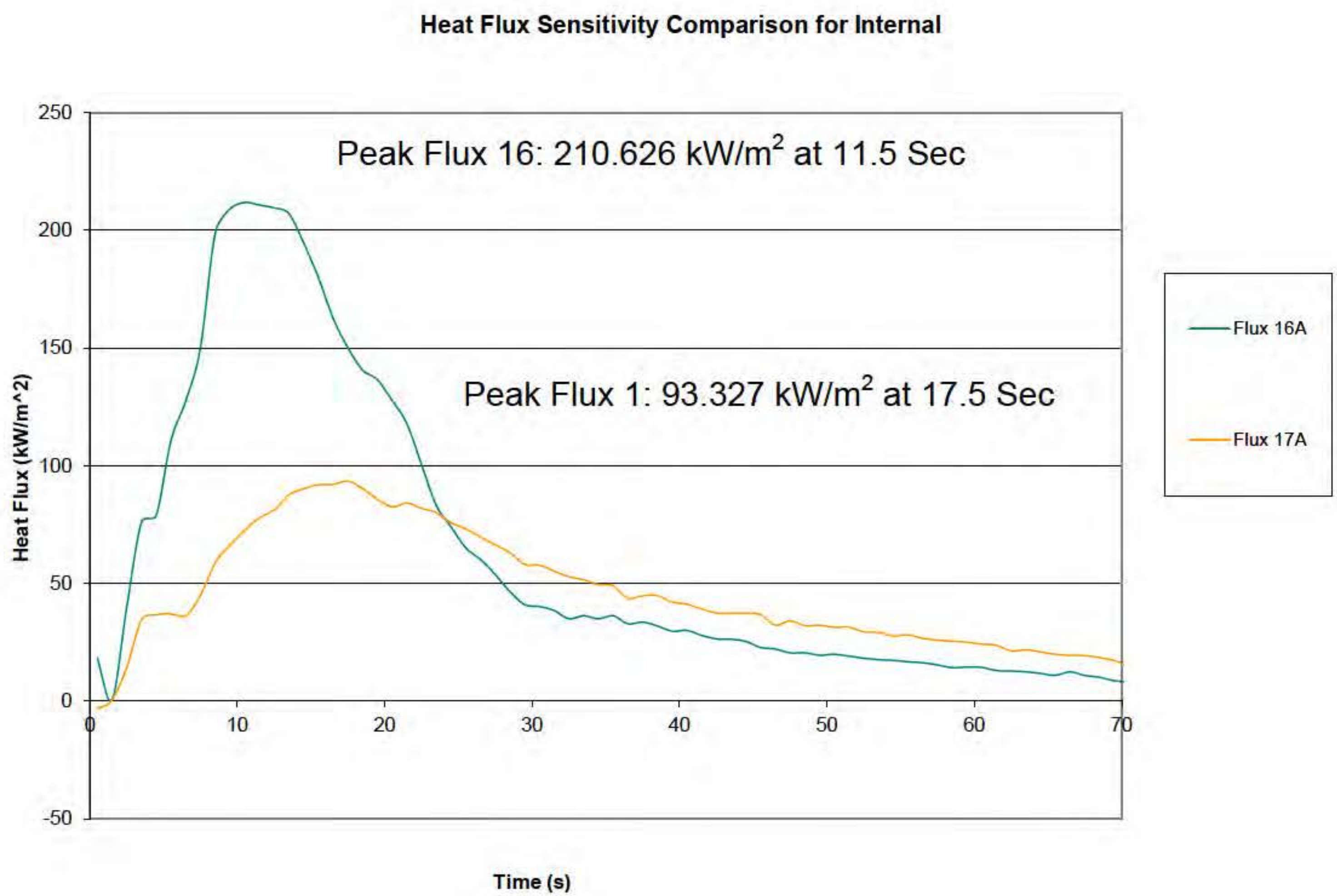

FIGURE V-B-56. Internal Flux Gages #16A and 17A.

Summary

- Peak Flux Inside Structure
    - DFT #16—210.626.91 kW/m^2 at 11.5 sec
    - DFT #17—93.327 kW/m^2 at 17.5 sec
- Peak Flux Outside Structure
    - DFT #13—1137.897 kW/m^2 at 13.5 sec (11ft 1 in)
    - DFT #6—132.47 kW/m^2 at 3.5 sec (59ft 3 in)
    - DFT #4—44.44 kW/m^2 at 11.5 sec (28ft 3 in, 46ft 11in west of centerline)
    - DFT #5—37.162 kW/m^2 at 8.5 sec (28ft 3 in)

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Appendix V-C

HD1.3 TEST 4. DETAILED TIMELINE

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TABLE V-C-1. Detailed Time Line for Test 4.

IRIG			Camera	Event
15 06 47 585105	47 585107	0	E, N	Flashbulb
	48 707106		E,	Flamelet out orifice
	48 505107		N	Fire in structure completely illuminates orifice
	48 725107		W	Flamelet out of orifice
	48 885105		N	Luminous flow out of orifice
	48 995107		W	Plume diameter > orifice diameter, good plume
	49 007106		E	plume diameter >orifice diameter
	49 335107		N	Plume diameter ≈ 2 x orifice diameter
	49 475106		W	Strong plume
	49 485107		W	Smoke starting at roof/N
	49 486106		S	Smoke out of roof/E wall, S/W corner, top of roof/W wall
	49 487106		E	Strong plume; starting to see smoke N/roof area, along roof/E, E/S wall joint
	49 505107		W	Black smoke roof/N, roof/W
	49 506106		S	Roof bulged, Increased smoke at locations listed 486106
	49 507106		E	Roof bulging; smoke roof/N, N wall around plate, roof/E near bulge
	49 515106		W	Intense fire out plate N, black smoke roof/N wall
	49 515107		N	Plume obscures structure
	49 516106		S	Roof continued to bulge, fire out E wall near top, fireball N side near roof/upper half of N wall
	49 517106		E	Smoke out of roof, fireball out upper N wall
	49 525106		W	Fireball out N, starting on roof
	49 526106		S	Continuation of 49 516106
	49 527106		E	Fireball out roof & lots of black smoke, larger fireball out N wall
	49 535106		W	Huge fireball out N & roof
	49 536106		S	Roof continue to rise, large fireball N, smoke out roof/W wall, roof/E wall, roof/S wall

TABLE V-C-1. Contd.

IRIG		Camera	Event
	49 537106	E	Increased fireballs
	49 545105	N	Large fireball
	49 545106	W	Fireballs merge into one
	49 546106	S	Continue 536106, roof just beginning to fracture
	49 547106	E	Roof coming off, black smoke, one large fireball
	49 557106	E	Roof about 45◦, fireball decrease in size, structure rocking back
	49 565106	W	Huge fireball, roof coming apart, roof/W wall coming apart
	49 566106	S	Roof continues to rise, more fracturing of roof
	49 567106	E	Fireball decrease over roof, fireball out N wall, door/frame coming off less than 45◦
	49 575106	W	Roof/N, roof/W fragments, door started to rotate out at top
	49 576106	S	Roof fractures coalesce producing frags
	49 585105	N	Fireball off ground above structure
	49 586106	S	Roof fragments produced and moving out, walls expanding at top; Fireball out N
	49 587106	E	No fireball over roof, door/frame ≈45◦
	49 595107	W	Roof fragmenting, fireball out N, door falling ≈45◦
	49 596106	S	More fracturing of roof & production of frags
	49 597106	E	Frags forming, door/frame ≈45◦
	49 605106	W	Individual frags start flying
	49 607106	E	Frags forming, door/frame ≈45◦, fireball somewhat detached
	49 615106	W	Door past 45◦ from vertical, fireball out N
	49 616106	S	More frags from roof, fracture top of walls
	49 617106	E	Roof ≈45◦, door/frame ≈45◦, some frags, fire coming from roof & above door, detached fireball
	49 625105	N	Fireball rises well above structure, no plume
	49 625105	W	Structure started to rotate back, fireball out N
	49 626106	S	Frags moving out, fireball on N diminished

TABLE V-C-1. Contd.

IRIG		Camera	Event
	49 627106	E	As in 617106, roof fracturing
	49 655107	W	Door $\approx 65^\circ$ from vertical, fireball starting out roof
	49 676106	S	Structure rocks back
	49 677106	E	As in 627106, structure rocked back, door $\approx 30^\circ$ from horizontal, frags from roof
	49 695107	W	Structure rotating, door almost horizontal, fireball half roof & out north
	49 705105	N	No visible fireball, totally out of field of view
	49 716106	S	S/W wall joint separating at top, lots of frags from roof
	49 735107	W	Fireball N & 1/2 roof, structure rotated about 1 foot at N above origin
	49 755107	W	structure rotated 1.5 feet above origin
	49 775107	W	Structure rotated 2 feet above origin
	49 777106	E	Door on ground, fireball out front, large frags
	49 787106	E	Fireball starting to grow
	49 825107	W	Much of frags going straight up
	49 835107	W	Lots of frags
	49 875107	W	Top part of walls fragmenting
	49 876106	S	Fireball in NW quadrant
	49 957107	E	Lots of small burning material out front of structure
	49 966107	S	Particulate flashes
	49 975106	W	Lots of fragments, fireball diminish in diameter to about 6 feet
	50 005107	N	Faint flame can be seen through smoke
	50 027107	E	Fire out front, particles burning
	50 055107	W	Lots of fragments, fireball diminishing
	50 116106	S	Roof about gone, lots of frags, fireball building
	50 237107	E	Fireball out front growing, none over roof
	50 295105	W	Lots of frags from walls & roof, pieces of rebar

TABLE V-C-1. Contd.

IRIG		Camera	Event
	50 406106	S	Lots of frags & debris, fireball growing
	50 507106	E	Fireball decreased, cellular structure
	50 567107	E	Fireball decreased, cellular structure
	50 646106	S	Fireball growing, lots of frags
	50 795107	W	Fireball increasing in diameter, still lots of frags
	50 957107	E	Fireball above roof & out door growing in size and intensity
	51 066107	S	Fireball growing, lots of frags, little evidence of roof
	51 067107	E	Fireball continues to grow in size & intensity, over entire roof & front
	51 147107	E	Fireball continues to grow in size & intensity
	51 257107	E	Very intense fireball, tops of wall fragments
	51 297106	E	Fireball growing
	51 375106	W	Fireball encompasses everything N of structure and ≈1.7 m above roof
	51 375107	N	Flame/fireball becoming more intense & seen through smoke
	51 477105	E	Fireball continues to grow
	51 525106	W	Huge fireball, very intense
	51545156	N	Significant fireball through smoke at top of frame, some frags starting to be seen
	51 597105	E	Frags, fireball continues to grow
	51 647107	E	Flame out walls, burning frags
	51 757107	E	Flame out E wall, S wall, really intense fireball roof & N wall
	51 826106	S	Large fireball on west and above structure, not much on east
	51 967106	E	Flame out E wall, S wall, really intense fireball roof & N wall, burning particles out of fireball
	52 077106	E	Flame out E wall, S wall, really intense fireball roof & N wall, burning particles out of fireball, number of burning particles increases

TABLE V-C-1. Contd.

IRIG		Camera	Event
	52 207106	E	Flame out E wall, S wall, really intense fireball roof & N wall, burning particles out of fireball, number of burning particles increases
	52 215106	N	Large frags “raining down
	52 537107	E	Really intense fireball N of structure, lots of burning particles
	52 545106	W	Throwing burning stuff out (propellant?)
	52 615107	N	Fireball moving to west, frags still “raining down”
	52 637107	E	Really intense fireball N of structure, lots of burning particles
	53 185106	N	Fire ball near ground & upper far west, frags
	53 267107	E	Really intense fireball N of structure, lots of burning particles; flame out E wall near top
	53 285106	N	Fireball “on ground” intensifying, seeing fireball through fire and smoke
	53 375106	W	Still very intense, throws barrel lid out
	53 526106	S	Few Frags, particulate burning
	54 467107	E	Really intense fireball N of structure, lots of burning particles
			Flame out E wall near top
	54 527106	E	Really intense fireball N of structure, lots of burning particles
			Flame out E wall near top
	54 877106	E	Really intense fireball N of structure, lots of burning particles
			flame out E wall near top
	55 075106	W	Still very intense fireball
	55 645106	W	Still very intense fireball
	55 787106	E	Really intense fireball N of structure, lots of burning particles
			Flame out E wall near top
	56 095106	W	Still very intense fireball but diminishing a bit
	56 165106	W	Still very intense fireball but diminishing a bit

TABLE V-C-1. Contd.

IRIG		Camera	Event
	56 475107	N	Fireball very large toward west, obscures structure, particulates burning at edge
	59 165106	W	Still very intense fireball but diminishing a bit
	55 255106	N	Large fireball, can see east corner of structure & instrumentation stand
	57 415107	N	Fireball very large toward west, obscures structure,
	59 406106	S	particulates burning at edge, frags silhouetted against fireball
			above roof level, S wall relatively intact
	59 786106	S	Intense fireball to N, S wall relatively intact, few frags, particulates burning
15 07	00 156106	S	Few frags, but intense fireball
	00 225105	N	Large fireball obscures structure
	00 836106	S	Few particulates burning, few, if any, frags, fireball out N but diminishing
	01 037107	E	Fireball starting to diminish
	01 725107	N	Can see bottom of structure with fireball above & obscuring
	02 477107	E	Diminishing but still a fireball
	02 515106	W	Diminishing but still white fireball
	02 595105	N	Fireball intensity decreasing, cellular, but appears a bit more dense because of summing in depth
	02 747107	E	Cellular fireball
	03 217107	E	Diminished cellular fireball
	03 545107	W	No longer white fireball
	04 435105	N	Faint flames, cellular
	04 756106	S	Still some cellular flame.
	04 845106	W	Still some flames
	05 357107	E	Very diminished cellular flame

Appendix V-D

HD1.3 TEST 4. HIGH-SPEED VIDEOS

(This appendix is included on the DVD.)

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Appendix V-E

HD1.3 TEST 4. DOPPLER DATA

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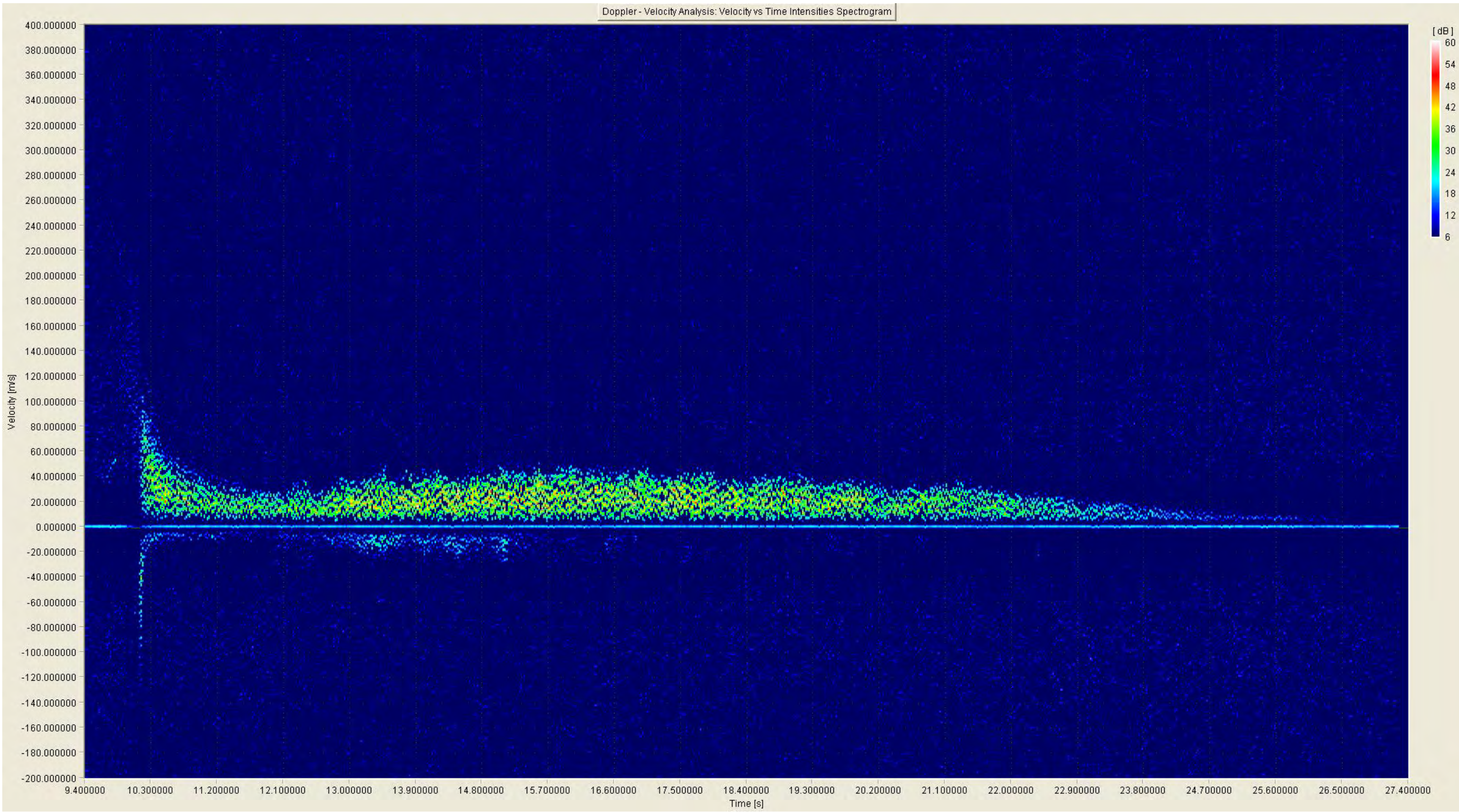

FIGURE V-E-1. 2K FFT Intensity.

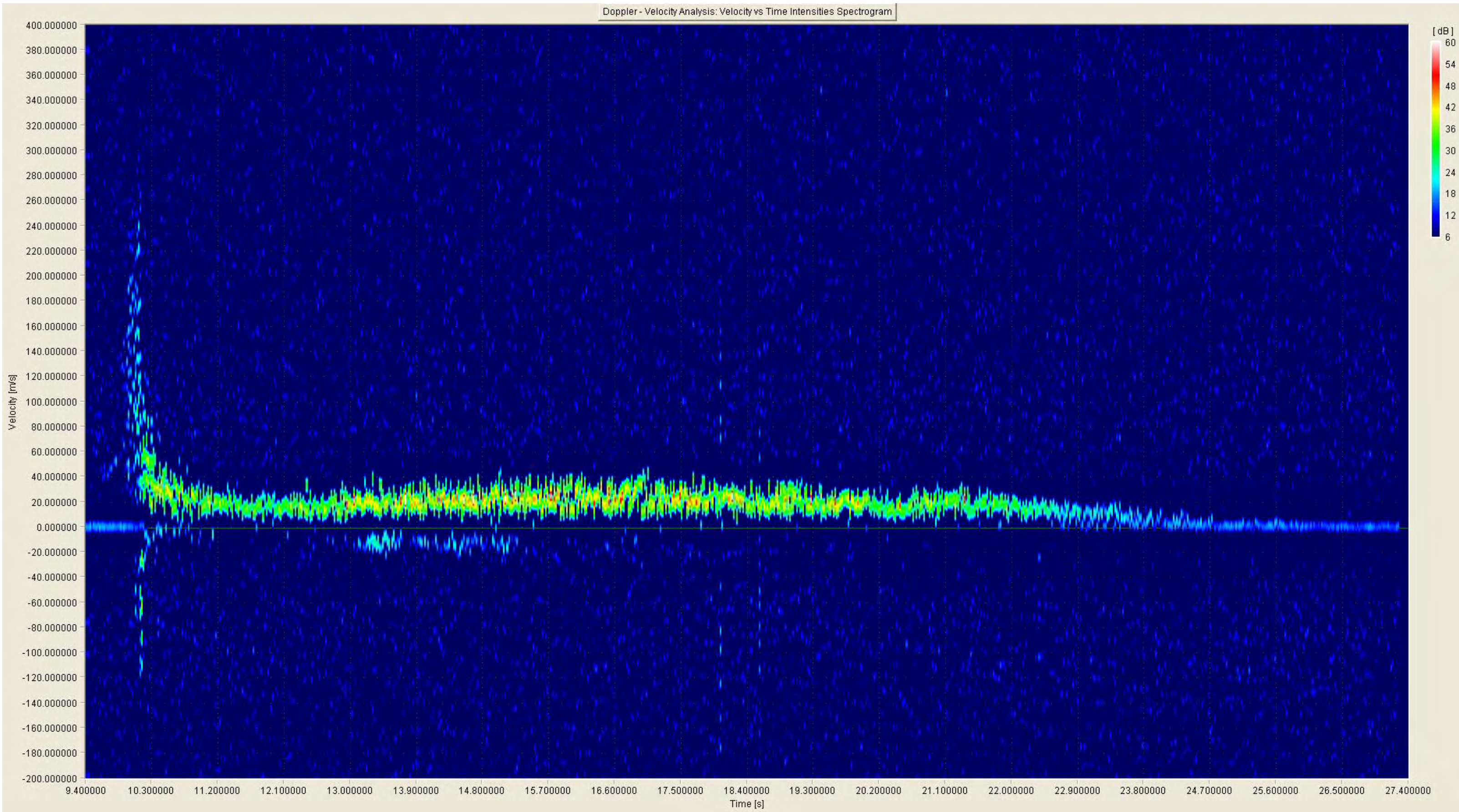

FIGURE V-E-2. 512K FFT Intensity.

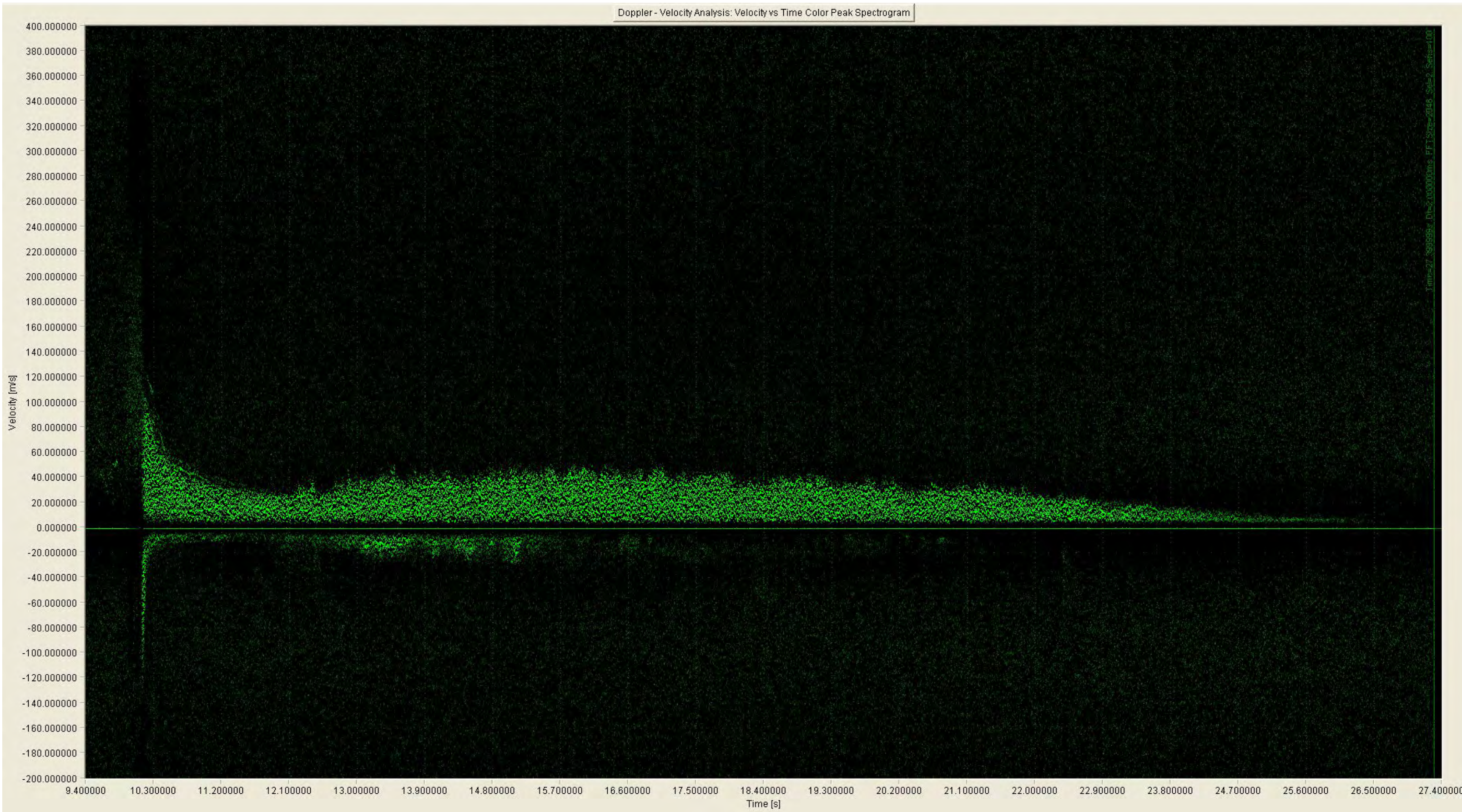

FIGURE V-E-3. 2K Color Spectrogram.

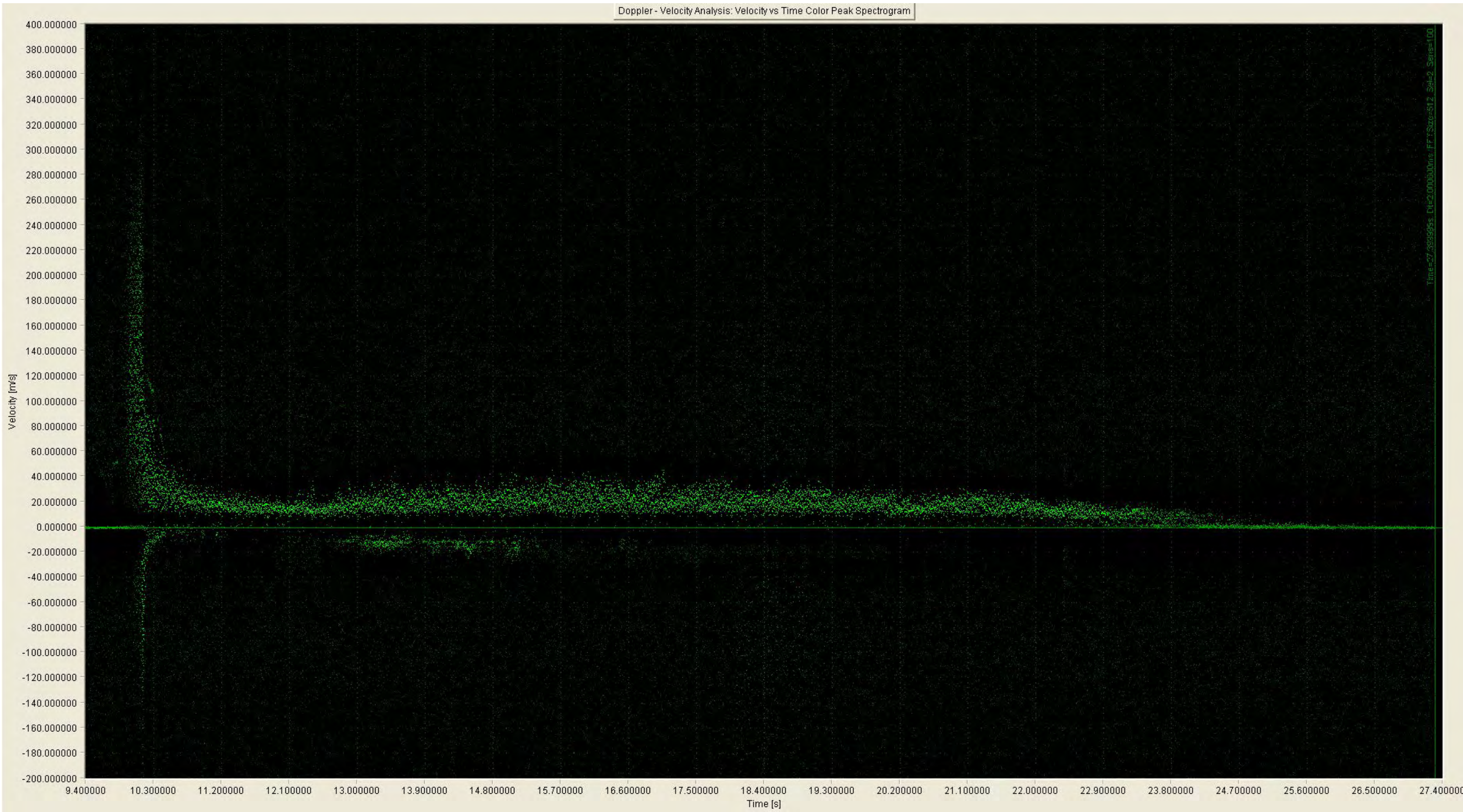

FIGURE V-E-4. 512K Color Spectrogram.

Summary

- Fragments Detected but tracking lengths were too short
- Initial Velocity of Plume 72 m/s
- Peak Velocity of Plume
  - 342 m/s away from structure
  - 245 m/s toward structure
- Duration of Plume 16.189 seconds

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Appendix V-F

HD 1.3 TEST 4. IR DATA

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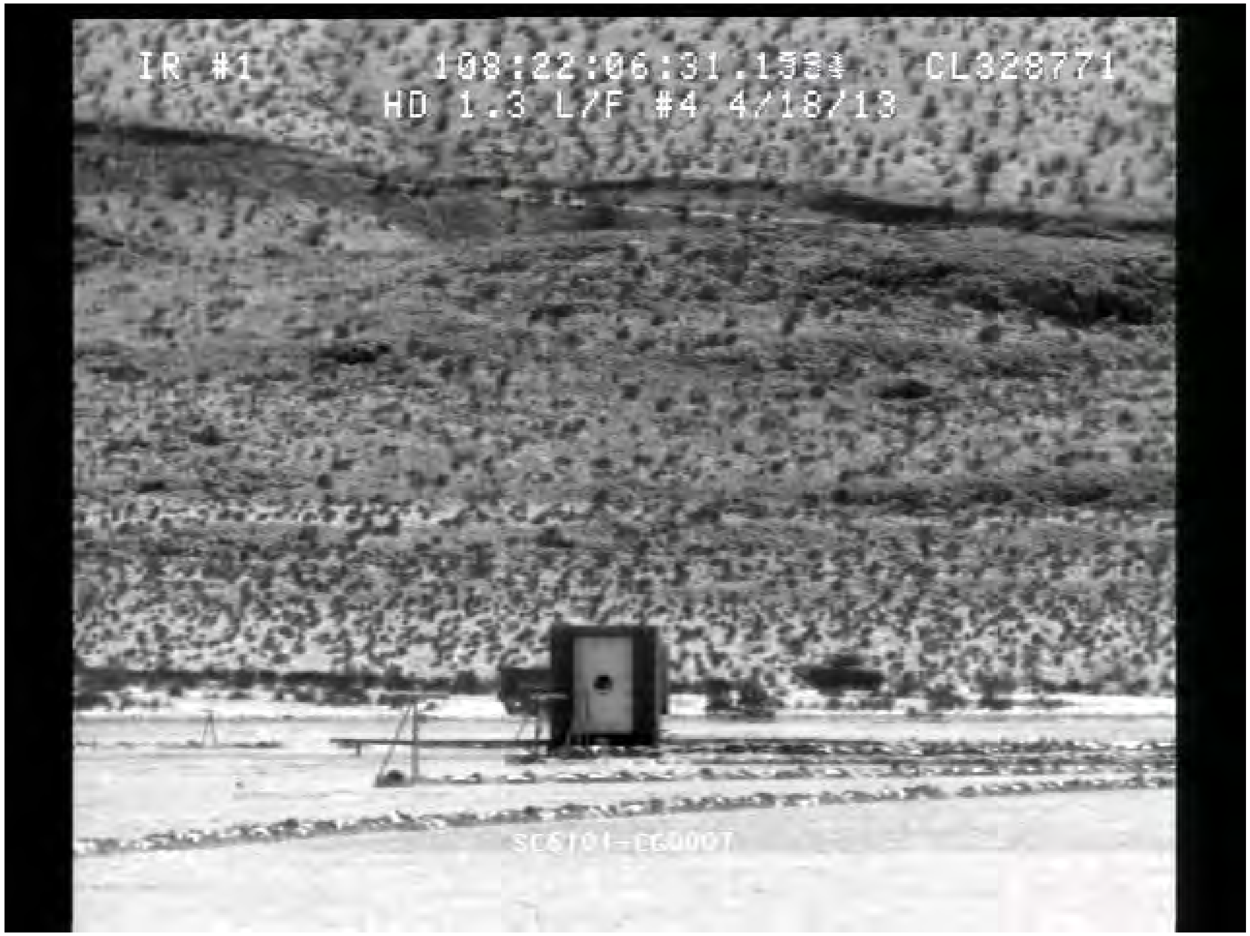

FIGURE V-F-1. Black and White IR Image #1, Camera 2.

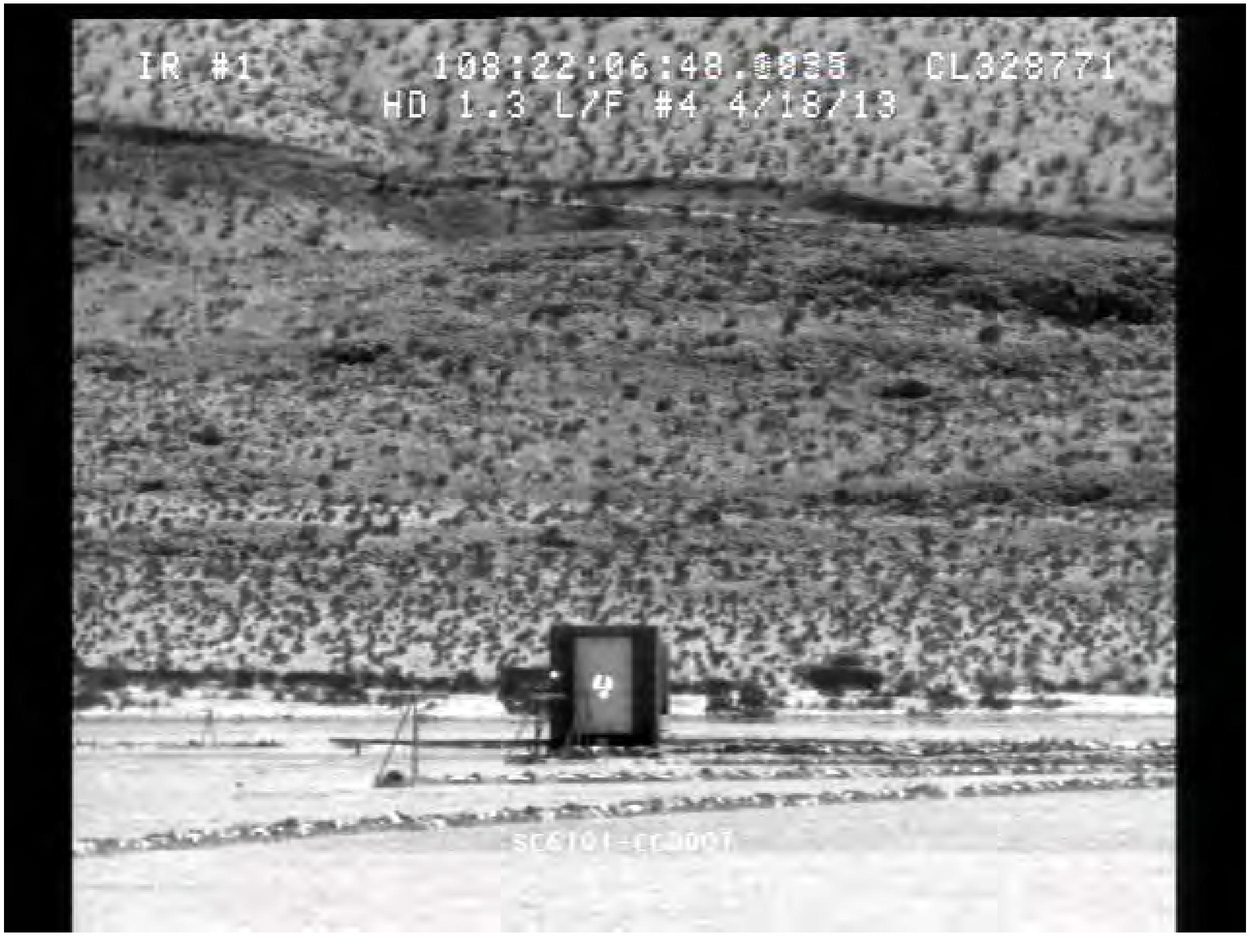

FIGURE V-F-2. Black and White IR Image #2, Camera 2.

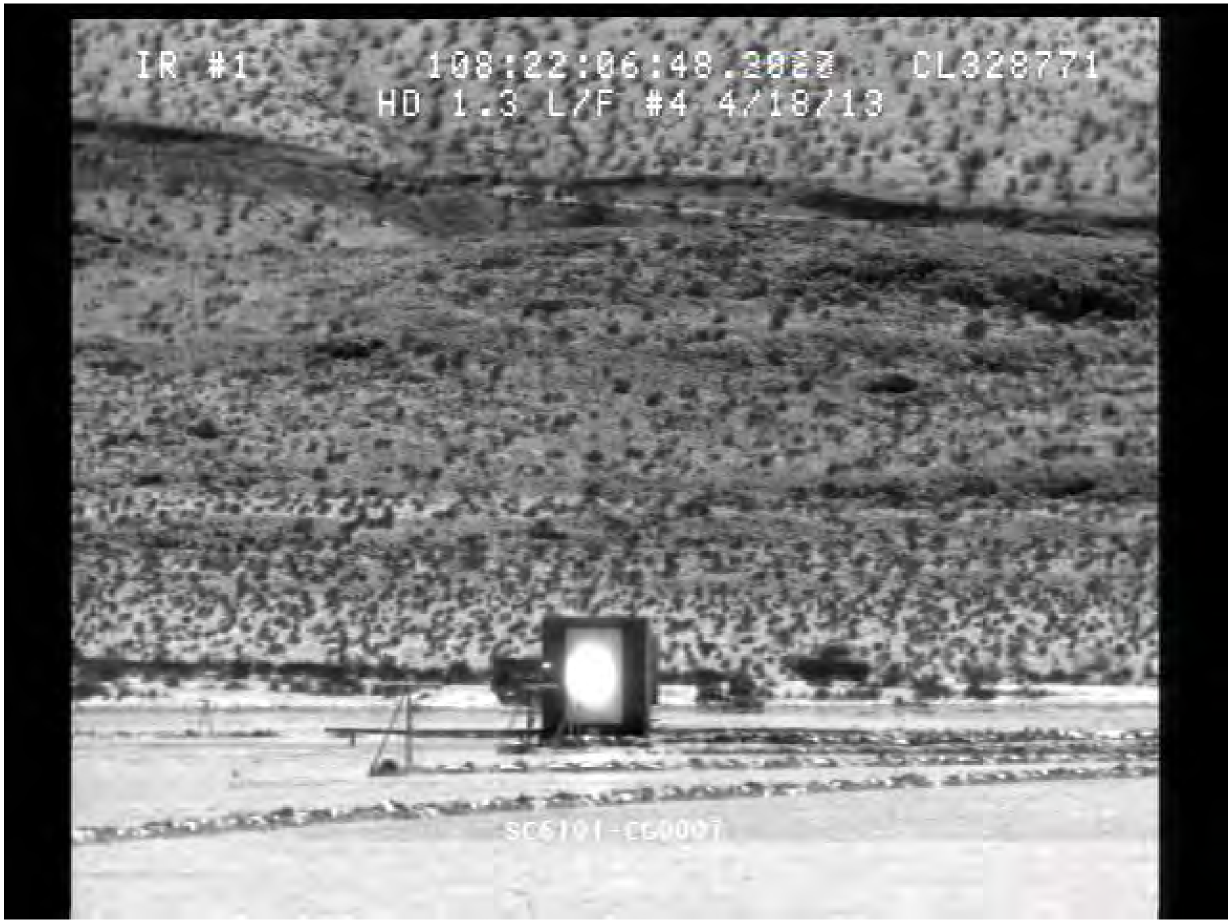

FIGURE V-F-3. Black and White IR Image #3, Camera 2.

FIGURE V-F-4. Black and White IR Image #4, Camera 2.

FIGURE V-F-5. Black and White IR Image #5, Camera 2.

FIGURE V-F-6. Black and White IR Image #6, Camera 2.

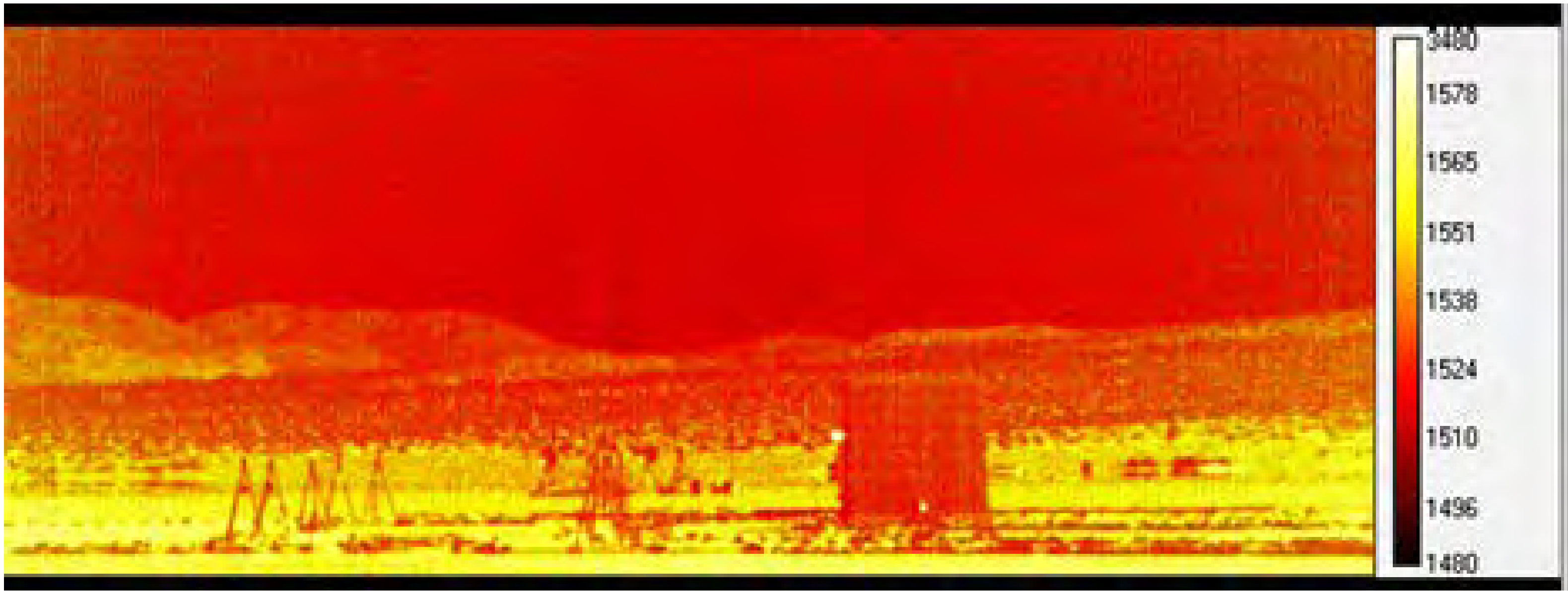

FIGURE V-F-7. IR Image With Intensity Scale #1, Camera 1.

FIGURE V-F-8. IR Image With Intensity Scale #2, Camera 1.

FIGURE V-F-9. IR Image With Intensity Scale #3, Camera 1.

FIGURE V-F-10. IR Image With Intensity Scale #4, Camera 1.

FIGURE V-F-11. IR Image With Intensity Scale #5, Camera 1.

FIGURE V-F-12. IR Image With Intensity Scale #6, Camera 1.

Appendix V-G

HD1.3 TEST 4. FRAGMENT DATA TABLE AND FRAGMENT MAPS

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This appendix is in two parts: (1) the fragment data table, and (2) fragment maps for each of the weight groups, with photographs of some of the most significant structural debris.

FRAGMENT DATA TABLE

The fragment data table is presented in Table V-G-1. The 3,000+ entries give the fragment identification number, the color of the fragment indicating where the fragment originated (black for roof, grey for north (front) wall, yellow for east wall, red for south (rear) wall, and green for west wall), the mass of the fragment in grams, notes such as photograph number if a photograph was taken, and the GPS coordinates in meters.

TABLE V-G-1. Fragment Data Table.

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
4420	Black	6.30		431110.3929	3974388.9440	93.64
4421	Black	2.50		431110.0310	3974378.6450	83.68
4422	Black	22.80		431109.5736	3974371.9214	77.16
4423	Black	10.20		431107.9071	3974369.9622	74.77
4424	Black	8.40		431113.5275	3974367.7793	74.71
4425	Black	15.80		431113.3630	3974372.7731	79.27
4426	Black	45.40		431119.2617	3974376.1245	84.65
4427	Black	3.70		431118.4189	3974370.6973	79.37
4428	Black	23.20		431119.3866	3974369.4412	78.66
4429	Black	15.10		431124.7269	3974376.9721	87.80
4430	Black	3.90		431117.7903	3974368.3086	76.95
4431	Black	7.60		431117.3791	3974367.2450	75.81
4432	Black	5.30		431118.0735	3974366.8446	75.76
4433	Black	1.60		431117.8173	3974366.9834	75.77
4434	Black	4.30		431117.7774	3974366.9834	75.75
4435	Black	7.50		431116.3407	3974366.8512	75.01
4436	Black	10.40		431115.4706	3974366.0647	73.93
4437	Black	23.50		431113.9282	3974365.1116	72.42
4438	Black	3.40		431116.1551	3974365.4323	73.65
4439	Black	15.40		431115.8225	3974363.7114	71.95
4440	Black	5.00		431113.6603	3974363.7116	71.03
4441	Other	0.00	001 impact	431126.4992	3974370.3566	82.86
4442	Black	1029.70	0001final rest p a475	431126.7142	3974371.2005	83.70

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
4443	Black	57.90		431128.3564	3974368.0797	81.89
4444	Black	9.10		431127.0723	3974366.4564	79.84
4445	Black	21.60		431130.7611	3974370.8490	85.52
4446	Black	46.60		431130.8299	3974372.1463	86.65
4447	Black	19.20		431144.1638	3974387.9575	107.18
4448	Black	21.90		431137.5036	3974377.4058	94.71
4449	Black	24.70		431144.9976	3974375.4465	97.57
4450	Black	4.00		431135.8073	3974373.6924	90.69
4451	Black	10.00		431139.5472	3974368.3913	88.65
4452	Black	7.80		431130.9878	3974361.1006	77.65
4453	Black	5.50		431127.0337	3974362.1541	76.21
4454	Black	10.00		431127.0344	3974359.8562	74.32
4455	Black	54.40		431130.4756	3974359.0442	75.70
4456	Black	9.80		431131.7491	3974358.0274	75.69
4457	Black	6.10		431130.6340	3974357.3079	74.43
4458	Black	32.60		431144.4086	3974365.3393	89.47
4459	Black	73.50		431154.6049	3974369.6861	99.64
4460	Black	38.10		431154.6048	3974376.5522	104.63
4461	Black	9.20		431145.5710	3974359.7695	86.24
4462	Black	210.50	pa478	431148.5762	3974359.5938	88.28
4463	Black	93.30		431140.8408	3974350.1140	76.16
4464	Black	15.30		431137.5953	3974351.4336	74.71
4465	Black	68.30		431146.6309	3974350.5307	80.82
4466	Black	9.10		431144.6490	3974348.8073	78.19
4467	Black	23.10		431147.8518	3974349.4623	81.09
4468	Black	154.50		431142.2393	3974348.1486	75.92
4469	Black	26.80		431146.5331	3974342.5142	75.87
4470	Black	32.00		431145.4569	3974336.6726	71.76
4471	Red	3.80		431148.9320	3974334.2981	73.57
4472	Red	12.00		431149.9360	3974334.3129	74.46
4473	Black	18.00		431155.5172	3974333.2892	78.97
4474	Yellow	23.00		431153.8271	3974264.4279	77.57
4475	Yellow	43.20		431148.8973	3974251.8593	79.90
4476	Black	21.10		431148.1254	3974250.5754	80.05
4477	Yellow	59.30		431145.2307	3974252.4058	76.64
4478	Yellow	13.10		431145.1238	3974251.7472	76.95
4479	Yellow	27.20		431151.3140	3974247.4008	84.51
4480	Yellow	15.00		431154.0899	3974246.9420	87.00
4481	Yellow	7.50		431151.9947	3974245.2808	86.35

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
4482	Yellow	60.20		431165.1727	3974237.3809	101.60
4483	Yellow	47.90		431168.7273	3974244.8405	100.23
4484	Yellow	51.20		431161.2965	3974248.5728	91.97
4485	Yellow	27.00		431162.4649	3974244.0632	95.47
4486	Yellow	22.80		431164.6701	3974248.2527	94.98
4487	Yellow	12.00		431163.6847	3974244.2006	96.39
4488	Yellow	14.30		431163.7369	3974238.2918	99.91
4489	Yellow	17.80		431159.3400	3974238.2319	96.49
4490	Yellow	13.60		431148.1912	3974241.7284	85.74
4491	Yellow	66.40		431143.6781	3974242.8831	81.64
4492	Yellow	17.40		431142.9489	3974243.3821	80.76
4493	Yellow	10.30		431143.4534	3974247.0214	78.68
4494	Yellow	7.30		431144.6967	3974248.1566	78.88
4495	Yellow	7.40		431150.8156	3974251.5514	81.64
4496	Yellow	13.70		431155.5831	3974256.3036	83.02
4497	Yellow	15.40		431157.4548	3974256.5875	84.49
4498	Yellow	36.00		431160.5777	3974257.2774	86.87
4499	Yellow	22.00		431173.0112	3974278.6582	90.93
4500	Yellow	24.90		431146.9430	3974258.6896	74.42
4501	Yellow	5.80		431153.3861	3974258.0075	80.26
4502	Yellow	2.70		431143.9430	3974255.4848	73.76
4503	Yellow	18.60		431153.5010	3974249.3368	85.11
4504	Yellow	36.50		431135.9863	3974245.1070	74.61
4505	Yellow	17.00		431135.1989	3974243.9372	74.92
4506	Yellow	9.00		431137.4778	3974247.5352	73.94
4507	Yellow	9.00		431137.6144	3974247.3008	74.20
4508	Yellow	4.30		431140.0886	3974243.5203	78.62
4509	Yellow	7.00		431136.5288	3974243.1362	76.42
4510	Yellow	28.40		431136.1320	3974241.3954	77.43
4511	Yellow	13.40		431141.4769	3974233.2745	87.06
4512	Yellow	8.30		431141.2546	3974232.8125	87.26
4513	Yellow	8.40		431137.0119	3974240.7145	78.53
4514	Yellow	7.90		431148.4137	3974231.5156	93.02
4515	Yellow	15.20		431140.0589	3974230.6520	88.15
4516	Yellow	21.70		431133.8002	3974233.4419	82.09
4517	Yellow	46.50		431137.3715	3974227.1151	89.30
4518	Yellow	18.70		431129.7823	3974230.6837	82.02
4519	Yellow	843.90	pa486	431138.4854	3974221.5719	94.45
4520	Yellow	48.80		431124.8322	3974236.9574	74.06

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
4521	Yellow	77.00		431131.8459	3974221.5795	90.81
4522	Yellow	11.80		431126.6818	3974224.7991	85.41
4523	Yellow	35.70		431122.1304	3974228.6714	79.81
4524	Yellow	11.00		431114.3758	3974230.4653	74.81
4525	Yellow	13.60		431111.2200	3974229.0541	74.91
4526	Red	18.00		431098.7482	3974224.3764	75.99
4527	Red	384.00	pa488	431063.0710	3974229.5761	72.62
4528	Red	6.40		431028.4199	3974226.0315	91.95
4529	Red	19.40		431025.0757	3974231.1725	90.09
4530	Red	17.30		431025.2288	3974231.8786	89.46
4531	Red	12.00		431029.9878	3974231.1518	86.96
4532	Red	13.50		431030.7533	3974230.9885	86.61
4533	Red	6.70		431022.0152	3974231.4921	91.90
4534	Red	54.00		431024.9517	3974238.2139	85.01
4535	Red	105.00		431030.1967	3974242.7736	78.08
4536	Red	23.90		431031.2213	3974234.5483	83.54
4537	Red	15.70		431030.7606	3974235.3948	83.19
4538	Red	12.20		431028.5185	3974234.1888	85.56
4539	Grey	171.90		431031.6159	3974230.2738	86.64
4540	Red	46.20		431026.3528	3974245.7823	78.73
4541	Red	42.60		431020.8037	3974241.6812	85.60
4542	Red	76.00		431027.1424	3974248.3810	76.41
4543	Red	1167.50	pa493	431012.9160	3974241.3925	91.79
4544	Red	448.00		431013.7056	3974243.3851	89.93
4545	Red	60.80		431015.3952	3974256.6315	80.95
4546	Red	15.90		431022.3981	3974257.7977	74.42
4547	Black	185.00		431080.0657	3974297.0781	4.72
4548	Black	110.00		431080.7007	3974297.4181	4.00
4549	Black	30.00		431080.3622	3974297.2541	4.38
4550	Black	260.00		431081.1637	3974297.5535	3.53
4551	Black	105.00		431080.2744	3974296.7288	4.69
4552	Black	355.00		431080.9981	3974296.7687	4.05
4553	Black	1510.00		431081.0881	3974296.5375	4.11
4554	Black	2970.00		431081.3600	3974296.9940	3.62
4555	Red	3265.00		431081.4992	3974296.8470	3.59
4556	Black	295.00		431081.3203	3974297.0192	3.64
4557	Red	4310.00		431081.6211	3974296.9046	3.46
4558	Red	430.00	and green	431081.4861	3974297.0189	3.50
4559	Red	3865.00		431081.9895	3974297.1359	3.03

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
4560	Black	240.00		431081.8173	3974297.2980	3.07
4561	Black	100.00		431081.8355	3974297.2020	3.11
4562	Black	230.00		431081.7388	3974297.3822	3.10
4563	Black	505.00		431081.7113	3974297.4241	3.10
4564	Black	420.00		431081.8060	3974297.6113	2.92
4565	Black	815.00		431081.7957	3974296.6747	3.47
4566	Black	525.00		431081.7686	3974296.6273	3.53
4567	Black	596.00		431081.5413	3974296.5326	3.76
4568	Black	470.00		431081.3522	3974296.4739	3.94
4569	Black	309.00		431081.4170	3974296.3793	3.95
4570	Black	205.00		431081.4456	3974296.2993	3.98
4571	Black	45.00		431081.2086	3974296.5605	4.00
4572	Black	1505.00		431081.3026	3974296.1839	4.17
4573	Black	589.00		431081.1443	3974295.9641	4.43
4574	Black	1200.00		431080.7604	3974295.8697	4.78
4575	Black	490.00		431080.8020	3974295.5517	4.97
4576	Black	580.00		431080.7137	3974295.4351	5.11
4577	Black	3780.00		431081.3080	3974295.7628	4.46
4578	Black	355.00		431081.3936	3974296.0493	4.19
4579	Black	280.00		431081.4315	3974296.1172	4.12
4580	Black	290.00		431081.2763	3974296.1048	4.24
4581	Black	270.00		431081.4387	3974295.9208	4.25
4582	Black	2000.00		431081.5056	3974295.8843	4.24
4583	Black	155.00		431081.4969	3974295.8191	4.29
4584	Black	1220.00		431081.6255	3974296.2911	3.86
4585	Other	2590.00	rebar	431082.3182	3974296.3650	3.34
4586	Red	4735.00		431081.8201	3974296.5463	3.54
4587	Black	190.00		431081.5864	3974296.4612	3.77
4588	Black	190.00		431081.7844	3974296.5330	3.58
4589	Red	1615.00		431081.9876	3974296.8748	3.20
4590	Black	210.00		431082.1343	3974297.0102	3.00
4591	Black	370.00		431082.0274	3974296.7961	3.22
4592	Grey	3690.00		431082.0395	3974296.5951	3.35
4593	Black	2910.00		431082.2990	3974296.5985	3.17
4594	Black	3155.00		431082.3557	3974296.5225	3.20
4595	Black	2600.00		431082.1989	3974296.2494	3.51
4596	Black	1140.00		431082.1822	3974296.0797	3.65
4597	Black	4375.00		431082.3171	3974296.0510	3.59
4598	Black	1010.00		431082.4025	3974296.1640	3.45

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
4599	Black	880.00		431082.4859	3974296.6658	3.00
4600	Black	2074.00		431082.5096	3974297.3145	2.51
4601	Black	800.00		431082.1344	3974296.8335	3.12
4602	Black	905.00		431082.3391	3974295.8869	3.72
4603	Black	860.00		431082.0357	3974295.6570	4.08
4604	Black	190.00		431081.6926	3974295.4135	4.48
4605	Black	150.00		431081.7179	3974295.1045	4.71
4606	Black	140.00		431081.3070	3974295.2368	4.85
4607	Black	320.00		431082.0913	3974294.9112	4.68
4608	Black	360.00		431082.0550	3974294.5701	5.00
4609	Black	2495.00		431081.8306	3974294.0144	5.59
4610	Black	850.00		431082.3096	3974294.3047	5.13
4611	Black	3890.00		431082.5225	3974293.9881	5.34
4612	Black	2745.00		431082.8373	3974294.5124	4.74
4613	Black	3640.00		431082.9588	3974294.8043	4.42
4614	Black	275.00		431083.0937	3974294.5545	4.62
4615	Black	240.00		431082.9720	3974294.7259	4.49
4616	Black	450.00		431083.0976	3974294.8885	4.30
4617	Black	330.00		431083.2829	3974294.8842	4.25
4618	Black	210.00		431082.9833	3974295.0827	4.15
4619	Black	210.00		431082.8160	3974295.4001	3.92
4620	Black	690.00		431082.6526	3974295.5954	3.81
4621	Black	370.00		431082.7654	3974295.8070	3.57
4622	Black	605.00		431082.6663	3974296.2669	3.22
4623	Black	430.00		431082.6656	3974296.6787	2.88
4624	Black	730.00		431083.0007	3974296.1342	3.18
4625	Black	6110.00		431083.2513	3974296.0738	3.13
4626	Black	580.00		431083.5579	3974296.6723	2.46
4627	Black	1030.00		431083.2341	3974295.8791	3.32
4628	Black	120.00		431083.0932	3974295.7523	3.49
4629	Black	2550.00		431083.6668	3974295.7583	3.31
4630	Black	1080.00		431083.9547	3974296.0650	2.96
4631	Black	200.00		431083.3473	3974295.4566	3.69
4632	Black	260.00		431083.5624	3974295.5840	3.51
4633	Black	50.00		431083.4862	3974295.8227	3.30
4634	Black	400.00		431082.2234	3974294.7757	4.74
4635	Black	450.00		431083.3450	3974294.4253	4.68
4636	Black	610.00		431083.5076	3974294.6714	4.41
4637	Black	540.00		431083.4167	3974294.3957	4.70

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
4638	Black	725.00		431083.4319	3974294.3275	4.76
4639	Black	560.00		431083.3623	3974294.1887	4.91
4640	Black	1095.00		431082.9986	3974294.0688	5.12
4641	Black	1245.00		431083.2197	3974294.0890	5.04
4642	Black	765.00		431083.3170	3974293.9716	5.13
4643	Black	265.00		431083.3409	3974294.2110	4.90
4644	Black	225.00		431083.1076	3974293.9783	5.18
4645	Black	599.00		431082.8179	3974293.8525	5.37
4646	Black	830.00		431083.0779	3974293.5338	5.61
4647	Black	520.00		431082.8151	3974293.5634	5.65
4648	Black	160.00		431082.8756	3974293.2044	5.98
4649	Black	775.00		431082.4652	3974293.1501	6.15
4650	Black	670.00		431082.2834	3974292.5853	6.74
4651	Black	295.00		431081.9146	3974292.7104	6.75
4652	Other	520.00	rebar	431081.5187	3974292.8122	6.81
4653	Black	160.00		431081.1534	3974292.8711	6.92
4654	Black	269.00		431080.8331	3974292.5678	7.34
4655	Black	1025.00		431080.8600	3974293.3490	6.65
4656	Black	310.00		431080.7461	3974293.5807	6.52
4657	Black	415.00		431079.9707	3974293.1483	7.32
4658	Black	350.00		431080.3684	3974294.0905	6.34
4659	Black	1180.00		431079.4099	3974291.6174	8.90
4660	Black	515.00		431079.9137	3974290.8607	9.28
4661	Black	515.00		431080.2654	3974290.6425	9.31
4662	Black	510.00		431079.1559	3974290.6286	9.86
4663	Black	460.00		431079.3958	3974289.5301	10.70
4664	Other	2039.00	rebar	431078.9895	3974288.7566	11.57
4665	Other	2030.00	rebar	431081.7133	3974291.3192	8.13
4666	Black	259.00		431081.2445	3974290.6979	8.87
4667	Black	135.00		431081.6391	3974291.2458	8.22
4668	Black	550.00		431081.8341	3974289.4942	9.84
4669	Black	200.00		431082.1498	3974289.8102	9.45
4670	Black	660.00		431081.3423	3974289.2867	10.17
4671	Black	675.00		431081.7212	3974287.9206	11.39
4672	Black	365.00		431081.1205	3974287.6279	11.82
4673	Black	80.00		431081.3385	3974287.1286	12.25
4674	Black	80.00		431078.9066	3974287.4863	12.74
4675	Black	110.00		431078.6561	3974287.1924	13.12
4676	Black	150.00		431078.6634	3974287.1690	13.13

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
4677	Black	45.00		431078.4809	3974288.0882	12.40
4678	Black	95.00		431079.1319	3974289.0195	11.27
4679	Black	260.00		431077.2073	3974285.0933	15.64
4680	Black	685.00		431077.3716	3974284.5578	16.05
4681	Black	695.00		431074.9409	3974284.0065	17.71
4682	Black	50.00		431078.9444	3974285.2904	14.74
4683	Black	135.00		431081.2866	3974284.6901	14.64
4684	Black	90.00		431082.2065	3974284.6773	14.48
4685	Black	890.00		431082.2188	3974285.6173	13.55
4686	Black	135.00		431081.8658	3974285.5761	13.65
4687	Black	600.00		431082.5895	3974286.7344	12.39
4688	Black	260.00		431082.2778	3974288.0494	11.15
4689	Black	250.00		431082.7824	3974288.0654	11.05
4690	Black	265.00		431083.0221	3974288.6043	10.48
4691	Black	880.00		431082.7306	3974288.8973	10.23
4692	Black	980.00		431083.4504	3974289.6575	9.38
4693	Black	215.00		431083.6006	3974288.5531	10.47
4694	Black	360.00		431084.1649	3974288.1416	10.85
4695	Black	725.00		431083.7761	3974287.3683	11.64
4696	Black	245.00		431083.6292	3974286.4236	12.59
4697	Black	105.00		431083.9915	3974285.4083	13.59
4698	Black	310.00		431084.3806	3974285.5616	13.43
4699	Black	130.00		431082.8273	3974283.8359	15.24
4700	Black	375.00		431081.7051	3974283.4038	15.82
4701	Black	950.00		431083.5281	3974279.1772	19.84
4702	Black	100.00		431083.2448	3974280.1594	18.87
4703	Black	190.00		431084.7217	3974278.0019	21.00
4704	Black	1405.00		431087.8355	3974279.9426	19.36
4705	Black	2235.00		431086.9542	3974280.9622	18.21
4706	Black	680.00		431086.5176	3974280.8728	18.25
4707	Black	860.00		431086.4844	3974280.8128	18.30
4708	Black	1815.00		431085.6952	3974282.0858	16.96
4709	Black	840.00		431084.5211	3974281.4466	17.55
4710	Black	220.00		431084.3032	3974282.6709	16.32
4711	Black	90.00		431083.3543	3974282.4565	16.57
4712	Black	395.00		431084.9595	3974283.0972	15.91
4713	Black	110.00		431084.8609	3974284.2195	14.78
4714	Black	570.00		431085.8953	3974284.3321	14.74
4715	Black	95.00		431086.1765	3974283.6717	15.43

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
4716	Black	950.00		431087.0901	3974283.0172	16.21
4717	Black	1175.00		431088.4055	3974282.3103	17.16
4718	Black	3980.00		431088.7932	3974280.8724	18.65
4719	Black	225.00		431088.9884	3974281.7634	17.84
4720	Black	255.00		431087.7246	3974283.3430	16.00
4721	Black	235.00		431087.2642	3974283.9353	15.33
4722	Black	170.00		431086.8590	3974283.8631	15.33
4723	Black	615.00		431087.0357	3974284.6040	14.63
4724	Black	130.00		431086.5384	3974284.4472	14.71
4725	Black	935.00		431086.0323	3974284.4849	14.60
4726	Black	670.00		431086.9782	3974285.0710	14.16
4727	Black	180.00		431087.4150	3974285.3356	13.99
4728	Black	1405.00		431086.9573	3974285.5378	13.70
4729	Black	685.00		431086.4200	3974285.4231	13.72
4730	Black	905.00		431086.5068	3974285.2517	13.91
4731	Black	480.00		431085.7097	3974285.5447	13.52
4732	Black	164.00		431084.9655	3974284.9803	14.03
4733	Black	145.00		431085.0105	3974286.1095	12.90
4734	Black	615.00		431085.1399	3974286.2401	12.78
4735	Black	785.00		431085.4515	3974287.0382	12.00
4736	Black	235.00		431085.4672	3974287.1245	11.92
4737	Black	235.00		431086.2911	3974286.6363	12.50
4738	Black	195.00		431086.2456	3974286.8503	12.29
4739	Black	470.00		431086.5800	3974287.0769	12.12
4740	Black	3630.00		431086.6873	3974287.2291	11.99
4741	Black	160.00		431086.0356	3974287.1499	11.96
4742	Black	690.00		431085.6642	3974287.4965	11.57
4743	Black	205.00		431085.2545	3974287.3961	11.63
4744	Black	675.00		431085.2876	3974288.0685	10.96
4745	Black	220.00		431086.2630	3974288.4616	10.70
4746	Black	3175.00		431086.4367	3974288.6034	10.59
4747	Black	245.00		431086.2599	3974289.3526	9.82
4748	Black	360.00		431085.8472	3974289.4728	9.63
4749	Black	849.00		431085.5527	3974289.6886	9.38
4750	Black	130.00		431085.5914	3974289.2883	9.78
4751	Black	3155.00		431085.1684	3974289.8797	9.15
4752	Black	790.00		431084.5962	3974289.6943	9.30
4753	Black	1140.00		431084.7674	3974290.1192	8.88
4754	Black	2175.00		431085.2226	3974290.6843	8.35

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
4755	Black	1010.00		431084.9255	3974291.0106	8.00
4756	Black	115.00		431085.4167	3974291.0781	7.98
4757	Black	245.00		431085.7217	3974291.3451	7.77
4758	Black	1630.00		431085.8224	3974291.5388	7.59
4759	Black	120.00		431083.2281	3974290.9761	8.10
4760	Black	795.00		431083.1522	3974291.2259	7.86
4761	Black	775.00		431083.1547	3974291.3294	7.76
4762	Black	95.00		431083.3427	3974291.5089	7.56
4763	Black	85.00		431083.3016	3974291.7253	7.35
4764	Black	485.00		431083.2490	3974292.6278	6.47
4765	Black	75.00		431082.8446	3974292.5919	6.58
4766	Black	110.00		431082.7322	3974292.3405	6.85
4767	Black	650.00		431083.7214	3974293.2589	5.77
4768	Black	210.00		431084.4296	3974293.1830	5.81
4769	Black	860.00		431084.2738	3974293.4409	5.55
4770	Black	80.00		431084.2747	3974293.1263	5.87
4771	Black	340.00		431084.1855	3974293.6963	5.30
4772	Black	570.00		431083.9946	3974293.7477	5.26
4773	Black	185.00		431083.9985	3974293.7273	5.28
4774	Black	205.00		431084.0308	3974294.0448	4.96
4775	Black	255.00		431083.3867	3974294.1873	4.91
4776	Black	815.00		431083.8914	3974294.7464	4.28
4777	Black	475.00		431083.6364	3974294.8660	4.19
4778	Black	3105.00		431083.9057	3974295.0541	3.97
4779	Black	1130.00		431083.9042	3974295.2738	3.75
4780	Black	195.00		431083.8184	3974295.5363	3.50
4781	Black	140.00		431084.3319	3974294.6764	4.32
4782	Black	930.00		431084.3928	3974295.1295	3.86
4783	Black	1860.00		431084.5325	3974294.9789	4.02
4784	Black	690.00		431084.5388	3974294.8749	4.12
4785	Black	200.00		431084.1478	3974295.0098	3.99
4786	Black	3170.00		431085.0172	3974294.7687	4.27
4787	Black	3610.00		431085.1127	3974294.5861	4.47
4788	Yellow	1850.00	and grey pa532	431084.8840	3974296.5319	2.51
4789	Black	395.00		431089.7292	3974283.4268	16.46
4790	Black	210.00		431089.7458	3974283.7627	16.15
4791	Black	1135.00		431090.8019	3974283.7980	16.50
4792	Black	120.00		431091.0113	3974284.2342	16.18
4793	Black	80.00		431090.9259	3974284.2217	16.16

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
4794	Black	2645.00		431090.3240	3974285.4837	14.76
4795	Black	115.00		431090.1126	3974285.5519	14.61
4796	Black	730.00		431088.6822	3974285.0842	14.56
4797	Black	129.00		431091.1704	3974286.0307	14.63
4798	Black	404.00		431091.3693	3974286.2188	14.56
4799	Black	185.00		431090.9652	3974287.4060	13.33
4800	Black	2525.00		431089.6922	3974286.9668	13.15
4801	Black	120.00		431089.5907	3974287.0744	13.01
4802	Black	2235.00		431087.8451	3974287.0242	12.46
4803	Black	325.00		431089.0828	3974287.4498	12.47
4804	Black	2175.00		431087.3107	3974287.7090	11.66
4805	Black	1065.00		431087.2519	3974289.2677	10.14
4806	Black	165.00		431087.0972	3974289.7063	9.68
4807	Black	540.00		431087.6261	3974290.2121	9.36
4808	Black	535.00		431090.3820	3974288.4484	12.13
4809	Black	90.00		431090.7827	3974288.3209	12.45
4810	Black	2240.00		431090.1756	3974288.8511	11.68
4811	Black	2110.00		431089.7315	3974288.8357	11.48
4812	Black	1440.00		431089.0577	3974289.1868	10.87
4813	Black	335.00		431090.1865	3974290.1708	10.56
4814	Black	210.00		431090.4144	3974290.7884	10.19
4815	Black	495.00		431091.7635	3974290.0156	11.62
4816	Black	310.00		431089.6755	3974292.6373	8.27
4817	Black	830.00		431088.6654	3974293.1738	7.23
4818	Black	1760.00		431089.3678	3974293.9097	7.12
4819	Black	520.00		431089.5647	3974294.2894	7.00
4820	Black	185.00		431088.3106	3974293.2113	6.99
4821	Black	130.00		431087.6492	3974293.4955	6.40
4822	Black	320.00		431087.6165	3974292.3032	7.43
4823	Black	130.00		431087.3168	3974292.5065	7.12
4824	Black	790.00		431087.1247	3974292.2810	7.25
4825	Black	220.00		431086.7575	3974292.5827	6.84
4826	Black	435.00		431086.1594	3974292.5821	6.65
4827	Black	1720.00		431087.4427	3974294.1606	5.72
4828	Black	290.00		431087.9447	3974295.3427	5.10
4829	Black	704.00		431086.9092	3974293.8751	5.71
4830	Black	165.00		431086.2308	3974293.8548	5.46
4831	Black	600.00		431086.0665	3974294.3312	4.96
4832	Black	830.00		431085.8918	3974293.7616	5.45

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
4833	Black	535.00		431085.0846	3974293.2498	5.79
4834	Black	895.00		431085.0057	3974293.6930	5.34
4835	Black	460.00		431085.4208	3974294.0609	5.04
4836	Black	960.00		431085.8402	3974294.8802	4.37
4837	Black	350.00		431086.0173	3974295.1280	4.20
4838	Black	3345.00		431086.1201	3974295.8952	3.55
4839	Black	305.00		431085.8415	3974295.9068	3.42
4840	Black	3600.00		431085.7636	3974295.7919	3.49
4841	Black	1595.00		431085.5507	3974295.7279	3.47
4842	Black	175.00		431085.3744	3974295.8337	3.31
4843	Black	2820.00		431085.5062	3974295.4067	3.76
4844	Black	235.00		431086.2405	3974296.8022	2.87
4845	Black	330.00		431085.8844	3974296.3915	3.01
4846	Black	165.00		431085.8355	3974296.8120	2.62
4847	Black	370.00		431085.6912	3974297.0853	2.32
4848	Yellow	675.00		431085.6579	3974297.0220	2.35
4849	Black	275.00		431085.7030	3974296.4488	2.87
4850	Black	4555.00		431085.5520	3974296.8860	2.41
4851	Black	340.00		431085.7202	3974297.2004	2.24
4852	Black	7100.00		431085.6319	3974297.4620	1.98
4853	Black	490.00		431085.5913	3974296.7106	2.58
4854	Black	475.00		431085.5252	3974297.1462	2.17
4855	Black	205.00		431085.6132	3974296.9572	2.38
4856	Black	305.00		431085.3671	3974296.4559	2.72
4857	Black	380.00		431085.3608	3974296.8540	2.35
4858	Black	395.00		431085.1416	3974296.8146	2.31
4859	Black	210.00		431084.9801	3974296.9105	2.17
4860	Black	640.00		431084.9752	3974294.7125	4.32
4861	Black	8740.00	pa535	431094.6235	3974288.6083	14.59
4862	Yellow	645.00		431094.6598	3974288.2960	14.84
4863	Black	180.00		431094.7768	3974288.3252	14.90
4864	Black	190.00		431092.9820	3974290.9704	11.76
4865	Black	155.00		431092.3624	3974292.3083	10.41
4866	Black	410.00		431079.8854	3974296.8959	4.96
4867	Black	285.00		431079.7466	3974296.7376	5.15
4868	Black	500.00		431079.6135	3974296.5231	5.37
4869	Black	270.00		431079.6177	3974296.9610	5.18
4870	Black	180.00		431079.0612	3974296.7536	5.77
4871	Black	190.00		431080.9228	3974296.7172	4.14

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
4872	Black	630.00		431081.6105	3974298.8003	2.78
4873	Black	205.00		431081.6581	3974298.5876	2.75
4874	Black	335.00		431081.3851	3974298.4928	3.04
4875	Black	635.00		431080.9926	3974298.9466	3.39
4876	Black	400.00		431080.6166	3974298.6101	3.78
4877	Black	135.00		431080.9424	3974298.6063	3.46
4878	Black	110.00		431079.3891	3974297.2557	5.29
4879	Black	240.00		431077.4688	3974297.2449	7.13
4880	Black	580.00		431077.4702	3974297.1421	7.15
4881	Black	250.00		431077.0725	3974297.8400	7.40
4882	Black	340.00		431076.9142	3974297.0795	7.71
4883	Black	155.00		431076.6718	3974297.1014	7.94
4884	Black	155.00		431076.9891	3974296.3875	7.84
4885	Black	270.00		431077.2132	3974295.8746	7.82
4886	Black	520.00		431075.3944	3974294.9908	9.84
4887	Black	164.00		431073.7790	3974294.3209	11.59
4888	Black	665.00		431072.1762	3974291.2504	14.45
4889	Black	375.00		431076.1703	3974291.0977	11.39
4890	Black	80.00		431075.7065	3974292.4000	10.90
4891	Black	70.00		431078.1593	3974291.2930	9.90
4892	Black	80.00		431077.3676	3974294.1083	8.55
4893	Black	110.00		431078.2565	3974296.0090	6.81
4894	Black	210.00		431077.9004	3974299.7441	6.52
4895	Black	145.00		431079.2802	3974298.7893	5.10
4896	Yellow	665.00		431083.3253	3974296.0771	3.10
4897	Black	45.80		431096.5549	3974349.7139	52.16
4898	Black	8.60		431095.7948	3974350.6418	52.89
4899	Black	48.40		431098.6387	3974354.0644	56.89
4900	Black	7.30		431104.2924	3974355.2337	59.66
4901	Black	4.00		431104.0406	3974354.1916	58.59
4902	Black	16.00		431097.1151	3974355.7801	58.20
4903	Black	26.00		431095.5944	3974357.6114	59.68
4904	Black	5.20		431093.0471	3974357.2083	58.86
4905	Black	3.00		431093.1858	3974351.8343	53.57
4906	Black	8.00		431089.1593	3974350.0357	51.26
4907	Black	3.00		431089.2233	3974352.1856	53.41
4908	Black	138.80		431016.5315	3974338.6282	78.58
4909	Black	517.90	cp827	431025.1226	3974344.7045	74.84
4910	Black	17.00		431082.3115	3974382.8181	83.85

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
4911	Black	38.70		431087.3027	3974369.9327	71.00
4912	Black	12.60		431101.7171	3974379.8805	82.72
4913	Black	52.60		431102.7677	3974366.6267	70.09
4914	Black	9.20		431104.9896	3974367.1223	71.18
4915	Black	14.40		431107.5263	3974379.0905	83.37
4916	Black	2.20		431106.1115	3974380.4195	84.28
4917	Black	2.90		431105.9589	3974383.4980	87.22
4918	Black	8.30		431107.8959	3974384.1952	88.39
4919	Black	9.10		431108.0483	3974381.8792	86.20
4920	Black	191.20	ap471	431108.3803	3974371.6639	76.53
4921	Black	10.60		431107.2732	3974366.4870	71.27
4922	Black	82.00		431109.1804	3974366.4708	71.89
4923	Black	2.50		431106.5765	3974368.0337	72.52
4924	Black	4.90		431110.2685	3974369.2027	74.83
4925	Black	10.70		431113.3254	3974371.0243	77.63
4926	Black	4.90		431111.2677	3974371.0351	76.89
4927	Black	6.00		431116.1532	3974372.5312	80.11
4928	Black	11.40		431117.9222	3974375.7588	83.77
4929	Black	37.30		431126.3704	3974389.9406	100.17
4930	Black	18.90		431131.8423	3974389.4833	102.18
4931	Black	59.80		431132.2408	3974385.3507	98.73
4932	Black	229.10	ap473	431133.3635	3974383.9339	98.05
4933	Black	28.50		431122.1715	3974364.1293	75.30
4934	Black	3.40		431121.3568	3974364.5570	75.27
4935	Black	3.20		431120.7097	3974365.7047	75.96
4936	Black	6.00		431125.7807	3974369.4899	81.75
4937	Black	4.50		431124.9569	3974367.7682	79.85
4938	Black	8.30		431120.8087	3974363.2580	73.87
4939	Black	2.30		431121.5216	3974361.6339	72.82
4940	Black	2.90		431121.5795	3974360.8386	72.17
4941	Black	2.20		431124.2227	3974361.6703	74.27
4942	Black	5.40		431129.6483	3974371.0404	85.09
4943	Black	4.70		431130.5793	3974374.2284	88.29
4944	Black	39.60		431129.2835	3974364.5951	79.50
4945	Black	240.80	ap476	431131.6923	3974366.4317	82.38
4946	Black	4.90		431131.4253	3974365.3168	81.31
4947	Black	5.10		431133.3842	3974364.1110	81.50
4948	Black	3.40		431130.6967	3974362.0477	78.24
4949	Black	6.00		431133.2463	3974359.6415	77.88

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
4950	Black	12.30		431138.0284	3974361.6383	82.48
4951	Red	148.80	ap477	431137.4452	3974357.6898	79.13
4952	Black	62.40		431133.8543	3974351.9565	72.47
4953	Black	18.80		431131.7732	3974353.7572	72.42
4954	Black	11.70		431131.5136	3974351.5439	70.59
4955	Black	10.70		431134.3079	3974355.3983	75.33
4956	Black	6.90		431134.1681	3974350.1224	71.36
4957	Black	972.70	ap479	431135.0750	3974347.8108	70.38
4958	Red	135.60	ap480	431139.2830	3974345.7220	72.10
4959	Red	34.60		431136.6099	3974347.1565	71.05
4960	Red	74.10		431171.7943	3974325.8191	91.44
4961	Yellow	29.10		431187.6516	3974258.3176	110.99
4962	Yellow	310.10	ap481	431199.6016	3974258.8594	122.01
4963	Yellow	82.00	ap482	431193.7511	3974226.3613	131.29
4964	Yellow	54.10		431183.7371	3974224.9356	123.92
4965	Yellow	148.10	ap483	431177.4929	3974226.6547	117.91
4966	Yellow	23.30		431166.9201	3974250.2954	95.83
4967	Yellow	32.20		431166.1776	3974262.9605	89.38
4968	Yellow	14.00		431162.6518	3974263.2458	86.05
4969	Yellow	43.60		431155.0025	3974267.0746	77.50
4970	Yellow	10.50		431154.8873	3974272.0524	75.48
4971	Yellow	360.40	ap484	431153.2886	3974274.7653	73.04
4972	Yellow	26.80		431158.6743	3974274.0331	78.37
4973	Yellow	16.30		431161.4312	3974275.5536	80.54
4974	Yellow	58.30		431172.3709	3974253.3164	99.14
4975	Yellow	27.50		431166.6070	3974286.9204	83.11
4976	Yellow	7.40		431168.8990	3974264.0501	91.46
4977	Yellow	5.10		431153.5928	3974256.4125	81.26
4978	Yellow	8.10		431158.4649	3974251.0667	88.24
4979	Yellow	20.50		431155.2264	3974250.8822	85.64
4980	Yellow	9.60		431156.2300	3974241.2865	92.15
4981	Yellow	12.60		431162.4042	3974232.0388	102.81
4982	Yellow	32.90		431162.3100	3974232.4317	102.49
4983	Yellow	55.40		431162.8267	3974227.6423	106.04
4984	Yellow	9.60		431154.0213	3974229.3549	98.49
4985	Yellow	30.00		431163.5531	3974218.5138	112.90
4986	Yellow	7.70		431166.3870	3974211.0108	120.28
4987	Yellow	27.70		431157.2384	3974213.1971	112.56
4988	Yellow	14.70		431149.9747	3974225.7716	98.31

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
4989	Yellow	26.30		431151.6360	3974222.1852	102.09
4990	Yellow	199.00	ap485	431118.5599	3974231.4547	75.70
4991	Yellow	143.30		431143.3079	3974215.6431	102.08
4992	Yellow	57.80		431148.5821	3974215.2809	105.50
4993	Yellow	96.60		431156.2290	3974203.2441	119.71
4994	Yellow	128.20	ap487	431155.5904	3974193.9969	126.87
4995	Yellow	20.40		431144.0337	3974211.0204	106.29
4996	Red	18.60		431039.1223	3974210.5657	99.34
4997	Red	27.70		431022.9817	3974229.4193	92.79
4998	Red	86.70		430998.6208	3974201.8736	129.57
4999	Red	48.80		431001.8384	3974217.6827	115.87
5000	Red	19.30		431003.0048	3974220.5450	113.03
5001	Red	100.60		431014.6983	3974230.3205	97.84
5002	Red	165.60	ap492	431015.8514	3974231.1660	96.42
5003	Red	78.40		431019.3797	3974232.9128	92.69
5004	Red	361.50	ap494	430963.9875	3974215.8531	146.31
5005	Green	54.80		431023.7439	3974326.1939	66.46
5006	Green	55.90		431024.3890	3974326.3434	65.93
5007	Green	14.60		431028.8868	3974331.4853	64.31
5008	Green	4.50		431025.7968	3974332.4689	67.47
5009	Green	21.40		431022.3971	3974334.5154	71.44
5010	Green	20.80		431025.8577	3974333.3539	67.86
5011	Green	9.70		431024.6044	3974336.1427	70.38
5012	Green	5.20		431027.9860	3974334.4412	66.61
5013	Green	5.60		431031.0212	3974331.2016	62.33
5014	Green	10.80		431030.1812	3974333.8865	64.46
5015	Black	5.70		431027.5804	3974339.1411	69.56
5016	Green	20.80		431029.0729	3974337.9494	67.65
5017	Green	7.20		431031.6746	3974336.3946	64.63
5018	Green	18.50		431025.4067	3974342.2105	73.11
5019	Black	6.40		431034.1548	3974340.5722	65.20
5020	Black	6.80		431038.4179	3974345.4212	65.33
5021	Black	18.20		431042.2371	3974348.3852	64.93
5022	Grey	102.30		431042.6380	3974352.9280	68.20
5023	Green	9.10		431042.7136	3974354.9895	69.80
5024	Black	8.10		431043.5930	3974359.5816	73.04
5025	Other	0.00	coverplate for metal box	431061.9369	3974366.1601	70.82
5026	Black	2.50		431067.2599	3974363.6774	66.91
5027	Black	5.50		431069.1224	3974360.6817	63.55

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
5028	Black	1.80		431078.9136	3974370.1390	71.35
5029	Black	7.50		431083.4623	3974360.6926	61.71
5030	Black	15.40		431089.5771	3974361.8421	63.06
5031	Black	8.70		431094.1695	3974368.7839	70.47
5032	Black	3.40		431095.2960	3974368.3973	70.26
5033	Black	9.10		431093.3312	3974358.9267	60.60
5034	Black	5.10		431096.6284	3974359.9956	62.22
5035	Black	5.40		431100.5035	3974365.8258	68.75
5036	Black	2.60		431100.0823	3974362.5630	65.48
5037	Black	156.50		431100.4725	3974357.9665	61.13
5038	Black	40.10		431101.5658	3974362.5096	65.80
5039	Black	5.70		431105.9563	3974363.0808	67.62
5040	Black	5.70		431108.2338	3974364.8156	70.01
5041	Black	65.70		431105.8442	3974359.8111	64.49
5042	Black	8.10		431107.6999	3974358.6521	64.05
5043	Black	21.10		431111.9452	3974362.7767	69.48
5044	Black	22.30		431110.7026	3974359.4638	65.95
5045	Black	6.10		431110.8792	3974358.7161	65.34
5046	Black	12.10		431110.0359	3974358.2357	64.56
5047	Black	38.00		431109.9388	3974357.1091	63.49
5048	Black	6.20		431109.2532	3974356.3211	62.49
5049	Black	7.20		431111.0889	3974356.6863	63.57
5050	Black	161.40		431111.7682	3974356.5090	63.70
5051	Black	6.90		431112.6520	3974359.4485	66.74
5052	Black	7.90		431115.1842	3974359.3974	67.80
5053	Black	19.10		431113.2906	3974357.1150	64.91
5054	Black	8.70		431107.9847	3974354.3716	60.20
5055	Black	9.30		431119.4816	3974359.8570	70.26
5056	Black	3.60		431120.5546	3974358.5113	69.65
5057	Black	12.70		431118.3121	3974355.6930	66.08
5058	Black	6.20		431118.8319	3974355.8821	66.51
5059	Black	255.30		431122.7480	3974355.9807	68.70
5060	Black	20.10		431112.5387	3974353.4666	61.32
5061	Black	272.90		431111.8229	3974353.0657	60.64
5062	Black	25.80		431110.3953	3974353.0195	59.96
5063	Black	181.00		431112.2801	3974350.2398	58.35
5064	Black	7.30		431111.3361	3974351.3274	58.87
5065	Black	22.80		431114.9722	3974353.2703	62.30
5066	Black	4.60		431122.4991	3974358.8811	70.99

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
5067	Black	5.20		431114.7401	3974354.4933	63.26
5068	Black	3.00		431115.3209	3974353.3889	62.58
5069	Black	4.20		431116.1386	3974351.7012	61.54
5070	Black	789.70	cp829	431113.5974	3974347.9185	56.98
5071	Black	29.50		431115.1884	3974349.3656	59.05
5072	Black	8.10		431119.9695	3974352.7000	64.43
5073	Black	11.70		431120.4439	3974352.2189	64.29
5074	Black	7.90		431124.5993	3974356.3776	70.07
5075	Black	7.80		431124.4651	3974355.1379	68.98
5076	Black	33.50		431117.6929	3974349.1879	60.24
5077	Black	6.70		431114.9295	3974348.3039	58.01
5078	Black	22.50		431116.0937	3974348.1489	58.50
5079	Black	9.50		431115.5272	3974347.2827	57.46
5080	Black	112.60		431116.4993	3974347.2169	57.94
5081	Black	3.10		431120.3273	3974350.3667	62.70
5082	Black	40.40		431121.1884	3974349.2200	62.27
5083	Black	9.90		431124.1358	3974346.1788	61.70
5084	Black	52.50		431119.9909	3974346.3535	59.25
5085	Black	12.00		431117.5286	3974345.0911	56.78
5086	Black	32.50		431118.5346	3974344.5638	56.95
5087	Black	319.30		431130.6088	3974344.5203	64.88
5088	Black	9.70		431132.1734	3974347.2104	67.89
5089	Black	5.80		431125.2546	3974339.7875	57.75
5090	Black	5.80		431126.2088	3974340.8183	59.15
5091	Black	4.60		431125.8101	3974341.9354	59.67
5092	Black	26.20		431130.4925	3974341.5440	62.74
5093	Black	10.70		431135.8121	3974344.3454	68.57
5094	Black	47.60		431130.4921	3974339.9090	61.65
5095	Black	15.00		431134.2610	3974337.5995	63.07
5096	Black	27.80		431133.9848	3974337.0407	62.51
5097	Black	6.90		431128.7947	3974336.7848	58.32
5098	Black	47.50		431132.5939	3974333.8572	59.50
5099	Black	52.60		431129.5283	3974335.3317	57.95
5100	Black	5.40		431128.3745	3974336.2204	57.63
5101	Black	5.70		431139.4367	3974339.1748	68.16
5102	Black	6.60		431131.5043	3974334.2574	58.86
5103	Black	17.10		431136.7643	3974331.6935	61.75
5104	Black	13.90		431137.8591	3974331.4362	62.55
5105	Black	18.40		431140.5618	3974333.4888	65.93

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
5106	Black	52.20		431144.5819	3974333.3186	69.30
5107	Red	9.50		431145.3402	3974321.3388	64.93
5108	Red	38.00		431149.0299	3974319.8331	67.92
5109	Black	6.00		431150.7282	3974314.0546	68.04
5110	Yellow	50.20		431144.8369	3974266.3149	68.72
5111	Yellow	36.50		431139.4231	3974268.7125	62.82
5112	Yellow	32.10		431142.4551	3974259.2465	70.37
5113	Yellow	27.10		431140.3531	3974258.5513	69.05
5114	Yellow	10.20		431140.0628	3974262.3568	66.65
5115	Yellow	16.30		431138.8071	3974260.5127	66.66
5116	Yellow	20.30		431137.4997	3974262.9142	64.21
5117	Yellow	7.90		431138.8527	3974258.2164	68.04
5118	Yellow	5.50		431136.1543	3974260.3834	64.59
5119	Yellow	17.50		431137.9214	3974257.9787	67.45
5120	Yellow	5.50		431137.5926	3974257.0803	67.74
5121	Yellow	5.80		431139.9147	3974253.7704	71.62
5122	Yellow	6.50		431138.2802	3974252.4545	71.21
5123	Yellow	33.70		431136.4763	3974252.1297	70.07
5124	Yellow	11.50		431136.6023	3974253.8211	69.05
5125	Yellow	53.40		431136.5717	3974249.7040	71.79
5126	Yellow	31.20		431132.7381	3974252.3745	67.17
5127	Yellow	3.60		431133.1624	3974251.8351	67.85
5128	Yellow	4.10		431135.4902	3974249.9750	70.82
5129	Yellow	36.20		431134.3740	3974249.4214	70.40
5130	Yellow	4.50		431133.1993	3974249.8260	69.29
5131	Yellow	4.20		431134.6091	3974247.7848	71.73
5132	Yellow	11.50		431130.1289	3974249.2917	67.55
5133	Yellow	36.00		431129.8432	3974246.6062	69.36
5134	Yellow	31.20		431130.5825	3974245.9393	70.35
5135	Yellow	7.50		431129.3820	3974247.2796	68.55
5136	Yellow	9.30		431124.2236	3974244.4854	67.52
5137	Yellow	60.50		431121.3424	3974240.7957	68.94
5138	Yellow	5.30		431122.3213	3974243.9242	66.87
5139	Yellow	6.30		431119.0493	3974242.9210	65.93
5140	Yellow	6.20		431119.3210	3974243.1087	65.91
5141	Yellow	6.70		431117.9682	3974244.0671	64.38
5142	Yellow	4.20		431112.0091	3974231.3262	73.09
5143	Yellow	10.20		431110.4607	3974239.2973	65.15
5144	Red	6.40		431090.4510	3974240.8354	58.47

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
5145	Red	6.70		431078.8521	3974231.4604	67.76
5146	Red	4.50		431073.0096	3974234.6805	65.31
5147	Red	4.40		431070.8075	3974234.5609	65.85
5148	Red	14.20		431069.5901	3974226.6039	73.89
5149	Red	8.90		431070.4700	3974228.1368	72.21
5150	Red	12.40		431067.9879	3974228.5456	72.33
5151	Red	11.70		431067.6246	3974236.0155	65.17
5152	Red	3.40		431043.1549	3974242.1013	70.26
5153	Red	22.40		431042.8136	3974243.5764	69.27
5154	Red	5.30		431048.1417	3974246.5709	63.73
5155	Red	4.60		431048.2688	3974245.4272	64.60
5156	Red	31.50		431039.5810	3974244.3321	70.68
5157	Red	37.60		431036.7058	3974241.3464	74.81
5158	Red	10.70		431035.1191	3974243.9698	73.85
5159	Red	4.70		431034.5018	3974243.9159	74.31
5160	Red	6.10		431041.5641	3974246.9042	67.43
5161	Red	15.70		431041.0065	3974248.8042	66.34
5162	Red	272.40		431036.9657	3974249.2524	68.72
5163	Red	229.50		431035.1112	3974247.8057	71.05
5164	Red	8.20		431035.0133	3974248.5073	70.61
5165	Red	88.40		431033.5735	3974246.8818	72.78
5166	Red	4.00		431039.9006	3974249.5398	66.51
5167	Red	25.80		431037.9630	3974252.6486	65.59
5168	Red	12.40		431038.6459	3974252.1029	65.50
5169	Red	21.30		431034.2403	3974249.9959	70.11
5170	Red	4.40		431036.9761	3974253.2264	65.89
5171	Red	12.40		431039.3553	3974254.1049	63.58
5172	Red	19.40		431041.5481	3974254.2440	61.95
5173	Red	11.20		431034.6232	3974255.3196	66.21
5174	Red	647.30	cp830-831	431031.9650	3974253.4584	69.43
5175	Red	7.20		431029.3626	3974251.3641	72.77
5176	Red	4.50		431028.9758	3974249.6239	74.21
5177	Red	8.70		431030.2366	3974255.3763	69.53
5178	Red	4.20		431028.1153	3974254.9521	71.45
5179	Red	19.40		431035.0420	3974258.3173	63.94
5180	Red	9.50		431027.2601	3974257.4963	70.60
5181	Red	295.20		431025.3873	3974260.7414	70.31
5182	Red	84.60		431029.2170	3974261.2341	66.85
5183	Red	3.40		431020.0181	3974267.6768	71.58

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
5184	Red	121.40		431024.6667	3974272.1966	65.45
5185	Black	4.50		431022.4149	3974302.9226	62.09
5186	Green	109.10		431022.0822	3974313.8053	64.04
5187	Green	14.30		431021.2728	3974313.3061	64.71
5188	Green	9.60		431024.6494	3974316.4821	62.24
5189	Green	9.50		431032.7602	3974326.3505	58.42
5190	Green	69.10	multicolor, cp832	431033.6724	3974338.1932	64.09
5191	Green	20.70		431036.0564	3974335.1286	60.34
5192	Green	6.60		431036.3495	3974334.4313	59.69
5193	Black	10.40		431035.3868	3974333.7405	60.06
5194	Green	8.30		431038.4937	3974333.0285	57.13
5195	Black	9.40		431036.2393	3974341.2848	64.08
5196	Green	4.20		431040.0069	3974338.3104	59.29
5197	Green	12.70		431041.6527	3974338.6090	58.27
5198	Green	65.90		431044.4609	3974337.5814	55.52
5199	Green	10.30		431045.6126	3974337.4169	54.58
5200	Black	33.20		431058.6385	3974353.6102	60.38
5201	Black	4.90		431056.6633	3974351.1667	59.08
5202	Grey	74.90		431064.5481	3974350.5345	55.22
5203	Black	10.70		431063.6670	3974347.1825	52.45
5204	Yellow	133.30	cp836	431067.8207	3974350.7038	54.30
5205	Black	18.00		431070.1239	3974354.8055	57.60
5206	Black	4.40		431077.2489	3974354.7069	56.17
5207	Black	253.90		431078.0280	3974351.8360	53.22
5208	Black	10.60		431077.4932	3974349.6014	51.07
5209	Black	14.00		431078.0975	3974348.6885	50.09
5210	Grey	345.20	cp837	431076.5641	3974343.9092	45.59
5211	Black	17.90		431081.6340	3974347.4618	48.55
5212	Grey	5.20		431082.5571	3974347.9805	49.02
5213	Black	4.50		431085.7557	3974354.8293	55.85
5214	Black	10.40		431087.2417	3974354.9907	56.07
5215	Black	16.90		431086.1958	3974351.4911	52.53
5216	Black	6.70		431087.4767	3974350.1321	51.23
5217	Black	11.70		431082.0184	3974345.2881	46.35
5218	Black	10.70		431084.4609	3974343.0580	44.06
5219	Grey	13.90		431083.0089	3974342.5850	43.61
5220	Black	6.70		431085.6089	3974343.0339	44.06
5221	Black	17.50		431088.7905	3974342.7391	43.97
5222	Black	63.90		431092.6639	3974345.8312	47.56

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
5223	Black	8.40		431093.7451	3974344.6488	46.60
5224	Black	31.80		431098.1585	3974347.9557	50.86
5225	Black	24.60		431097.5701	3974351.8261	54.45
5226	Black	3.10		431097.0244	3974351.6194	54.12
5227	Black	3.90		431095.5296	3974351.2209	53.40
5228	Black	11.50		431094.6097	3974352.0055	53.99
5229	Black	59.00		431094.6477	3974352.9592	54.93
5230	Black	6.60		431092.4521	3974354.6358	56.22
5231	Black	3.30		431090.9941	3974356.7462	58.13
5232	Black	360.00		431086.7187	3974297.3780	2.84
5233	Black	320.00		431085.9913	3974297.4590	2.22
5234	Black	180.00		431085.9526	3974298.0972	1.81
5235	Grey	155.00		431086.0083	3974298.3725	1.74
5236	Yellow	430.00		431087.0585	3974296.5629	3.62
5237	Black	155.00		431086.9494	3974296.5839	3.52
5238	Black	130.00		431086.6527	3974296.6301	3.28
5239	Black	360.00		431088.2112	3974296.8672	4.38
5240	Black	110.00		431088.2333	3974296.1071	4.81
5241	Black	135.00		431088.1597	3974296.8006	4.37
5242	Black	115.00		431088.4001	3974297.0963	4.44
5243	Black	160.00		431088.1833	3974298.3228	3.86
5244	Black	240.00		431088.5570	3974296.0729	5.10
5245	Black	150.00		431089.0137	3974295.9520	5.54
5246	Black	230.00		431090.4946	3974297.0835	6.41
5247	Black	25.00		431089.3408	3974296.2244	5.68
5248	Black	220.00		431090.3280	3974295.6690	6.81
5249	Black	750.00		431091.3139	3974295.1518	7.93
5250	Black	3535.00	pa654	431090.3056	3974293.9058	7.81
5251	Black	170.00		431091.4845	3974294.4204	8.45
5252	Black	380.00		431092.3839	3974294.3534	9.25
5253	Black	110.00		431092.0467	3974293.1444	9.64
5254	Black	105.00		431091.6801	3974293.0598	9.41
5255	Black	200.00		431093.3224	3974293.6176	10.43
5256	Black	1190.00		431094.3357	3974293.4338	11.40
5257	Black	430.00		431095.1206	3974294.6065	11.60
5258	Black	2025.00	pa655	431096.1022	3974291.7040	13.80
5259	Black	190.00		431098.0333	3974293.4026	14.75
5260	Black	1660.00		431101.6225	3974297.1127	17.34
5261	Black	4390.00	pa656 657	431102.2946	3974299.1443	17.91

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
5262	Black	95.00		431099.0427	3974301.2112	14.83
5263	Black	695.00		431097.4986	3974306.1259	14.93
5264	Black	2120.00		431090.8572	3974304.1853	8.30
5265	Black	90.00		431089.2086	3974304.1016	7.03
5266	Black	6325.00	pa658	431090.3194	3974307.7225	10.56
5267	Black	3775.00		431088.8813	3974307.8031	9.89
5268	Black	280.00		431086.9286	3974305.4811	6.97
5269	Black	250.00		431086.0436	3974303.8274	5.11
5270	Black	190.00		431085.4604	3974303.5726	4.70
5271	Black	460.00		431085.3380	3974303.7964	4.90
5272	Black	210.00		431086.5593	3974303.4867	4.99
5273	Grey	255.00		431086.8712	3974301.8753	3.81
5274	Black	1520.00		431087.0158	3974301.3809	3.56
5275	Black	1050.00		431085.9919	3974301.7299	3.17
5276	Black	1060.00		431086.3202	3974301.1864	2.93
5277	Grey	4920.00		431085.6876	3974300.6737	2.13
5278	Grey	810.00		431086.2394	3974300.7598	2.56
5279	Grey	1460.00		431085.9775	3974300.5265	2.21
5280	Black	420.00		431085.8588	3974300.4868	2.10
5281	Grey	1420.00		431085.8046	3974300.0744	1.79
5282	Grey	2890.00		431085.5731	3974300.2489	1.73
5283	Grey	285.00		431085.6287	3974300.1553	1.70
5284	Grey	770.00		431085.4492	3974300.1796	1.60
5285	Grey	1140.00		431085.5906	3974300.4851	1.92
5286	Grey	2800.00		431085.6118	3974299.9324	1.55
5287	Grey	630.00		431085.7038	3974299.7487	1.52
5288	Grey	3830.00		431085.6829	3974299.5429	1.41
5289	Grey	3905.00		431085.5708	3974299.7037	1.39
5290	Grey	2605.00		431085.3310	3974299.5211	1.09
5291	Grey	1450.00		431085.2923	3974299.8035	1.22
5292	Black	2630.00		431086.6033	3974299.7030	2.33
5293	Black	205.00		431091.9573	3974311.5186	14.64
5294	Black	780.00		431094.6047	3974312.8510	17.22
5295	Black	200.00		431091.2750	3974315.7679	18.14
5296	Black	2620.00		431090.1146	3974318.1211	19.97
5297	Black	415.00		431091.9848	3974316.9432	19.49
5298	Black	910.00		431085.3352	3974314.9728	16.01
5299	Black	2635.00		431082.9411	3974309.4246	10.53
5300	Black	3940.00		431079.7164	3974308.3072	10.42

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
5301	Black	705.00		431078.9305	3974308.7593	11.18
5302	Black	3150.00		431080.3598	3974305.9521	8.04
5303	Black	240.00		431079.9618	3974305.9155	8.21
5304	Black	320.00		431078.6264	3974306.5442	9.49
5305	Black	450.00		431076.9031	3974309.8679	13.20
5306	Black	8790.00	pa659	431074.4349	3974305.3769	11.82
5307	Black	250.00		431074.1242	3974304.5612	11.67
5308	Black	120.00		431074.9523	3974304.2406	10.79
5309	Black	210.00		431075.1958	3974304.0466	10.48
5310	Black	240.00		431075.3165	3974303.8036	10.26
5311	Black	520.00		431075.8225	3974304.4379	10.14
5312	Black	340.00		431076.0008	3974304.0962	9.81
5313	Black	360.00		431077.1364	3974303.7746	8.68
5314	Black	305.00		431077.9679	3974303.1057	7.62
5315	Grey	8750.00	pa660	431078.3092	3974301.9585	6.76
5316	Black	1870.00		431076.8568	3974300.5028	7.67
5317	Black	220.00		431078.6650	3974301.5008	6.24
5318	Black	2495.00		431079.6662	3974301.3284	5.26
5319	Black	3150.00		431080.7839	3974301.6389	4.46
5320	Grey	510.00		431081.8757	3974300.4871	2.92
5321	Black	986.00		431082.0795	3974300.3887	2.69
5322	Black	90.00		431082.1372	3974300.1246	2.51
5323	Black	470.00		431081.7149	3974300.1063	2.89
5324	Black	1140.00		431082.3523	3974300.1826	2.35
5325	Grey	4910.00		431082.3648	3974299.8678	2.20
5326	Green	2235.00		431082.4067	3974299.8418	2.15
5327	Black	220.00		431082.6500	3974300.2117	2.12
5328	Grey	1510.00		431083.4112	3974298.8637	0.98
5329	Black	760.00		431082.6666	3974300.9676	2.61
5330	Grey	250.00		431082.9422	3974300.5780	2.14
5331	Grey	510.00		431082.8832	3974300.9289	2.45
5332	Black	570.00		431083.2008	3974300.6603	2.04
5333	Grey	4390.00		431083.3942	3974301.2071	2.42
5334	Grey	1660.00		431083.4323	3974300.8926	2.12
5335	Black	1650.00		431083.2939	3974300.7841	2.09
5336	Grey	560.00		431083.4640	3974300.5472	1.80
5337	Grey	1510.00		431083.2616	3974300.3814	1.78
5338	Grey	1215.00		431083.5418	3974300.4543	1.68
5339	Grey	1555.00		431083.4183	3974300.2358	1.57

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
5340	Grey	4600.00		431083.7726	3974300.2940	1.44
5341	Grey	2140.00		431083.9072	3974300.2484	1.34
5342	Grey	1790.00		431083.9496	3974300.7364	1.79
5343	Grey	2730.00		431084.0957	3974301.2864	2.31
5344	Grey	3650.00		431083.7646	3974300.2293	1.38
5345	Grey	505.00		431084.0425	3974302.1704	3.19
5346	Grey	830.00		431084.4721	3974301.1881	2.20
5347	Grey	350.00		431083.9963	3974301.1994	2.24
5348	Black	565.00		431080.6408	3974302.8415	5.37
5349	Black	340.00		431080.6607	3974301.9628	4.76
5350	Black	455.00		431079.3930	3974302.8757	6.32
5351	Black	430.00		431079.2659	3974303.1667	6.60
5352	Black	455.00		431069.3104	3974304.4462	16.03
5353	Black	2470.00		431069.0973	3974304.6253	16.29
5354	Black	260.00		431068.8290	3974304.6518	16.55
5355	Black	380.00		431069.4101	3974305.7321	16.42
5356	Black	805.00		431067.8943	3974307.0042	18.33
5357	Black	3030.00		431066.5401	3974307.7472	19.87
5358	Black	3490.00		431066.0017	3974306.8389	19.98
5359	Black	6375.00	pa661	431090.3821	3974276.7261	23.06
5360	Black	4535.00	pa662	431092.1132	3974274.2701	25.91
5361	Black	3905.00	pa663	431093.8222	3974278.1248	22.91
5362	Black	2295.00		431087.1535	3974276.4921	22.67
5363	Black	235.00		431089.8246	3974280.3348	19.44
5364	Black	1510.00		431090.2690	3974281.3846	18.57
5365	Black	985.00		431090.6536	3974281.8627	18.24
5366	Black	200.00		431091.2384	3974282.9460	17.45
5367	Black	305.00		431091.7059	3974282.9764	17.61
5368	Black	486.00		431093.7777	3974280.8444	20.44
5369	Black	305.00		431094.9543	3974283.3168	18.91
5370	Black	370.00		431097.1463	3974281.3032	21.82
5371	Black	2720.00		431100.9255	3974310.5666	20.19
5372	Black	2260.00		431102.6331	3974311.1494	21.93
5373	Black	700.00		431103.5636	3974314.9817	24.97
5374	Black	465.00		431099.5343	3974312.1583	20.07
5375	Black	385.00		431099.4889	3974310.4805	18.98
5376	Black	870.00		431095.0969	3974316.9689	20.93
5377	Black	2995.00		431102.3996	3974321.0725	28.50
5378	Black	350.00		431108.5574	3974322.9756	34.05

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
5379	Black	5245.00		431107.9050	3974325.8409	35.69
5380	Black	11555.00	pa664	431095.2883	3974327.1851	30.23
5381	Black	525.00		431103.3059	3974325.8012	32.81
5382	Black	200.00		431101.6034	3974331.9989	37.23
5383	Black	2945.00		431097.5610	3974333.1665	36.63
5384	Black	380.00		431095.7380	3974330.5272	33.52
5385	Black	415.00		431085.6744	3974329.7315	30.76
5386	Black	160.00		431079.0758	3974328.4193	29.90
5387	Black	910.00		431056.0784	3974322.3088	36.67
5388	Black	625.00		431055.0343	3974325.6837	39.67
5389	Black	1315.00		431058.4557	3974311.2505	28.68
5390	Black	225.00		431061.9587	3974310.7231	25.30
5391	Black	215.00		431063.7804	3974313.6252	25.27
5392	Black	3635.00		431065.6474	3974313.5003	23.69
5393	Black	45.00		431088.0198	3974285.2810	14.19
5394	Black	60.00		431087.7456	3974285.8130	13.60
5395	Black	20.00		431087.6321	3974285.5839	13.80
5396	Black	25.00		431087.2992	3974285.6873	13.62
5397	Black	18.00		431089.6981	3974285.6242	14.39
5398	Black	10.00		431089.2690	3974285.6978	14.17
5399	Black	115.00		431089.3389	3974286.1729	13.75
5400	Black	15.00		431089.0390	3974286.3334	13.49
5401	Black	5.00		431088.8954	3974285.0978	14.61
5402	Black	30.00		431089.1065	3974286.5420	13.32
5403	Black	35.00		431088.3380	3974287.3512	12.30
5404	Black	80.00		431091.2266	3974287.4636	13.41
5405	Black	20.00		431090.9767	3974287.4700	13.28
5406	Black	15.00		431087.1934	3974286.7431	12.57
5407	Black	30.00		431086.3411	3974286.8003	12.35
5408	Black	75.00		431092.4081	3974287.1345	14.32
5409	Black	60.00		431092.0609	3974286.7932	14.42
5410	Black	50.00		431086.8411	3974288.4478	10.83
5411	Black	85.00		431087.2280	3974287.6148	11.73
5412	Black	20.00		431090.1273	3974287.4502	12.90
5413	Black	30.00		431090.8890	3974287.6013	13.12
5414	Black	45.00		431088.3839	3974287.4350	12.23
5415	Black	45.00		431088.5367	3974287.3609	12.35
5416	Black	60.00		431091.1476	3974288.8516	12.19
5417	Black	25.00		431090.9929	3974288.4991	12.40

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
5418	Black	25.00		431088.8554	3974287.2836	12.54
5419	Black	80.00		431089.0395	3974286.7797	13.07
5420	Black	30.00		431088.4110	3974289.5724	10.25
5421	Black	35.00		431088.9762	3974289.3604	10.67
5422	Black	15.00		431086.2707	3974289.7854	9.40
5423	Black	105.00		431086.5321	3974289.4500	9.78
5424	Black	25.00		431088.1417	3974290.0363	9.72
5425	Black	25.00		431088.3980	3974289.8506	9.99
5426	Black	25.00		431084.6573	3974289.0701	9.93
5427	Black	50.00		431085.1722	3974288.7483	10.28
5428	Black	90.00		431087.4632	3974290.9449	8.62
5429	Black	105.00		431087.9455	3974290.2604	9.43
5430	Black	35.00		431084.6694	3974288.4137	10.58
5431	Black	20.00		431085.1216	3974287.8985	11.12
5432	Black	105.00		431087.8744	3974291.5108	8.26
5433	Black	45.00		431088.2258	3974291.4390	8.48
5434	Black	25.00		431083.2582	3974289.3286	9.73
5435	Black	55.00		431084.1580	3974289.0645	9.93
5436	Black	40.00		431087.4893	3974291.9611	7.69
5437	Black	50.00		431087.7973	3974291.9057	7.87
5438	Black	45.00		431084.6308	3974290.0288	8.97
5439	Black	30.00		431084.7193	3974290.2181	8.78
5440	Black	20.00		431087.6898	3974292.3068	7.46
5441	Black	30.00		431087.5889	3974292.0503	7.65
5442	Black	50.00		431084.5963	3974290.6360	8.36
5443	Black	45.00		431084.7316	3974290.7794	8.22
5444	Black	130.00		431085.5155	3974291.8405	7.24
5445	Black	65.00		431085.5955	3974291.8878	7.21
5446	Black	45.00		431085.2877	3974289.5749	9.46
5447	Black	35.00		431085.3700	3974290.1313	8.92
5448	Black	40.00		431086.5460	3974291.0630	8.22
5449	Black	85.00		431086.2252	3974290.7574	8.44
5450	Black	35.00		431082.4471	3974291.5267	7.71
5451	Black	35.00		431083.3477	3974291.1527	7.91
5452	Black	120.00		431084.7891	3974292.4947	6.51
5453	Black	80.00		431085.0884	3974292.6022	6.43
5454	Black	25.00		431082.9792	3974290.1598	8.94
5455	Black	40.00		431083.4423	3974289.1746	9.86
5456	Black	80.00		431084.7611	3974293.2080	5.80

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
5457	Black	35.00		431084.9144	3974293.4565	5.56
5458	Black	75.00		431087.9194	3974289.7046	9.94
5459	Black	65.00		431088.2175	3974288.8656	10.83
5460	Black	50.00		431083.4290	3974292.9032	6.17
5461	Black	85.00		431083.9734	3974293.0468	5.96
5462	Black	70.00		431088.8628	3974291.3481	8.86
5463	Black	145.00		431089.0994	3974290.4152	9.79
5464	Black	100.00		431082.9432	3974293.8934	5.30
5465	Black	60.00		431083.3507	3974294.2409	4.86
5466	Black	60.00		431090.0241	3974289.4416	11.10
5467	Black	65.00		431090.0887	3974289.0332	11.48
5468	Black	55.00		431082.8210	3974293.0139	6.18
5469	Black	55.00		431082.6972	3974293.2851	5.95
5470	Black	50.00		431085.2354	3974292.3995	6.65
5471	Black	60.00		431085.4940	3974292.2245	6.86
5472	Black	55.00		431084.5541	3974294.2586	4.74
5473	Black	75.00		431084.5944	3974293.9890	5.01
5474	Black	15.00		431086.8957	3974291.3339	8.06
5475	Black	30.00		431086.4975	3974290.3229	8.93
5476	Black	160.00		431085.1256	3974294.7394	4.32
5477	Black	95.00		431085.6024	3974294.9376	4.24
5478	Black	25.00		431086.9855	3974291.3035	8.12
5479	Black	20.00		431087.6493	3974291.1915	8.46
5480	Black	55.00		431084.6858	3974295.1842	3.82
5481	Black	80.00		431084.7870	3974295.3035	3.71
5482	Black	70.00		431090.8904	3974284.0929	16.26
5483	Black	35.00		431091.1215	3974283.7976	16.62
5484	Black	90.00		431084.4677	3974295.4786	3.52
5485	Black	100.00		431084.6383	3974295.5383	3.47
5486	Black	60.00		431086.1605	3974295.0807	4.30
5487	Black	135.00		431086.3104	3974294.2768	5.10
5488	Black	100.00		431084.7123	3974295.6189	3.39
5489	Black	70.00		431084.7635	3974295.7975	3.22
5490	Black	140.00		431085.8930	3974295.9333	3.41
5491	Black	130.00		431086.4059	3974295.6897	3.88
5492	Black	20.00		431084.9278	3974295.8222	3.22
5493	Black	105.00		431085.0674	3974296.3365	2.75
5494	Black	55.00		431085.2284	3974294.5788	4.50
5495	Black	60.00		431085.7880	3974293.8546	5.33

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
5496	Black	95.00		431084.8553	3974296.3749	2.66
5497	Yellow	115.00		431085.1327	3974296.3650	2.73
5498	Grey	165.00		431083.1765	3974295.3971	3.79
5499	Black	75.00		431084.1175	3974294.9124	4.09
5500	Black	80.00		431085.1083	3974296.6557	2.45
5501	Black	125.00		431085.4885	3974296.8563	2.41
5502	Black	195.00		431082.3342	3974295.7807	3.81
5503	Black	230.00		431082.8376	3974295.7791	3.57
5504	Black	165.00		431085.3073	3974296.6859	2.49
5505	Black	135.00		431085.5342	3974296.5548	2.70
5506	Black	120.00		431083.5211	3974295.6941	3.41
5507	Grey	205.00		431083.7537	3974295.6742	3.38
5508	Black	60.00		431085.3947	3974295.6486	3.50
5509	Black	80.00		431085.6276	3974295.3390	3.86
5510	Black	115.00		431084.3926	3974295.2935	3.70
5511	Black	135.00		431084.6569	3974295.5170	3.49
5512	Black	70.00		431087.2904	3974294.0425	5.74
5513	Black	30.00		431087.7327	3974293.9756	6.04
5514	Black	150.00		431088.5582	3974293.0007	7.31
5515	Black	60.00		431089.2306	3974293.5463	7.29
5516	Black	45.00		431089.5383	3974293.6346	7.44
5517	Black	150.00		431090.1161	3974293.1712	8.17
5518	Black	105.00		431089.9661	3974292.7942	8.34
5519	Black	55.00		431086.1638	3974292.4597	6.77
5520	Black	65.00		431087.1834	3974292.4457	7.12
5521	Black	135.00		431083.9484	3974293.7422	5.27
5522	Black	45.00		431084.1775	3974293.4073	5.59
5523	Black	40.00		431084.5666	3974292.6279	6.37
5524	Black	30.00		431084.9776	3974292.2091	6.81
5525	Black	60.00		431081.5164	3974293.2532	6.42
5526	Black	90.00		431081.9914	3974294.0953	5.45
5527	Black	50.00		431082.8011	3974294.3659	4.89
5528	Black	35.00		431083.7006	3974294.4241	4.62
5529	Black	120.00		431080.4105	3974294.6628	5.88
5530	Black	80.00		431080.1406	3974295.1274	5.74
5531	Red	130.00		431081.3721	3974296.4897	3.91
5532	Black	230.00		431081.8017	3974296.3662	3.68
5533	Black	50.00		431079.6248	3974296.3530	5.44
5534	Black	40.00		431080.0595	3974296.2085	5.14

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
5535	Black	50.00		431081.2254	3974296.0336	4.33
5536	Black	45.00		431081.8270	3974296.0440	3.90
5537	Black	85.00		431078.7140	3974296.3544	6.25
5538	Black	75.00		431079.1430	3974296.2743	5.90
5539	Red	60.00		431081.9397	3974296.6146	3.41
5540	Red	100.00		431082.4043	3974296.4372	3.23
5541	Black	45.00		431079.0429	3974297.5598	5.53
5542	Black	40.00		431079.3845	3974297.5441	5.20
5543	Black	115.00		431081.6980	3974297.0077	3.34
5544	Black	110.00		431082.0991	3974296.6147	3.30
5545	Black	105.00		431077.8926	3974298.5642	6.50
5546	Black	35.00		431078.2235	3974298.2428	6.20
5547	Black	140.00		431082.0816	3974296.9439	3.08
5548	Black	200.00		431082.2647	3974296.9257	2.96
5549	Black	20.00		431078.8748	3974294.4260	7.15
5550	Black	65.00		431079.0543	3974294.9376	6.70
5551	Red	65.00		431082.3570	3974296.8864	2.92
5552	Black	125.00		431082.5629	3974296.7470	2.89
5553	Black	35.00		431080.0773	3974293.0090	7.37
5554	Red	55.00		431082.1897	3974297.0796	2.91
5555	Black	145.00		431082.6186	3974296.9450	2.70
5556	Black	165.00		431081.1292	3974298.2351	3.34
5557	Black	190.00		431081.0562	3974298.8901	3.33
5558	Black	105.00		431082.7939	3974296.2126	3.20
5559	Black	55.00		431082.8210	3974295.9002	3.47
5560	Black	90.00		431081.7693	3974297.8151	2.87
5561	Black	235.00		431082.5749	3974297.9313	2.10
5562	Black	125.00		431082.6036	3974295.5214	3.90
5563	Black	135.00		431082.0289	3974295.8172	3.95
5564	Black	100.00		431081.2899	3974296.7348	3.83
5565	Black	130.00		431081.9056	3974296.7140	3.37
5566	Black	90.00		431083.3841	3974296.4998	2.69
5567	Black	85.00		431083.6705	3974296.0440	3.03
5568	Black	250.00		431082.6719	3974298.6452	1.74
5569	Black	155.00		431082.5547	3974298.3546	1.93
5570	Black	160.00		431082.1437	3974296.4536	3.39
5571	Black	155.00		431082.0846	3974296.1360	3.67
5572	Black	90.00		431080.9930	3974296.4982	4.21
5573	Black	75.00		431081.3755	3974297.2096	3.50

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
5574	Black	55.00		431080.9443	3974295.1239	5.18
5575	Black	85.00		431081.0870	3974295.4199	4.86
5576	Red	40.00		431082.1062	3974296.6149	3.29
5577	Black	360.00		431082.0941	3974296.6291	3.29
5578	Black	70.00		431081.2890	3974297.0404	3.66
5579	Black	75.00		431081.8009	3974296.8196	3.37
5580	Red	20.00		431082.3534	3974296.4895	3.22
5581	Black	275.00		431082.2040	3974296.5312	3.29
5582	Black	275.00		431082.5486	3974296.8129	2.85
5583	Black	410.00		431082.5522	3974296.4497	3.13
5584	Red	20.00		431082.2825	3974296.6594	3.14
5585	Black	235.00		431081.9588	3974296.5959	3.41
5586	Grey	60.00		431083.3498	3974296.5692	2.64
5587	Black	180.00		431083.3901	3974296.5123	2.67
5588	Black	90.00		431083.9731	3974296.2810	2.74
5589	Black	135.00		431082.2635	3974296.2753	3.45
5590	Black	85.00		431081.5949	3974296.5739	3.69
5591	Black	150.00		431081.8493	3974296.9174	3.27
5592	Black	60.00		431083.7116	3974296.1487	2.92
5593	Black	190.00		431082.1469	3974297.1148	2.92
5594	Black	160.00		431081.9744	3974297.5257	2.82
5595	Black	185.00		431081.3348	3974296.8699	3.71
5596	Black	190.00		431081.9313	3974297.9854	2.65
5597	Green	100.00		431081.6447	3974298.4428	2.79
5598	Black	80.00		431082.1383	3974298.1230	2.41
5599	Black	90.00		431081.3057	3974296.4999	3.96
5600	Red	40.00		431081.0758	3974295.9726	4.48
5601	Black	85.00		431081.1419	3974296.0264	4.39
5602	Black	180.00		431082.6992	3974296.7187	2.83
5603	Black	80.00		431083.0472	3974296.6438	2.70
5604	Black	245.00		431084.5633	3974295.0875	3.91
5605	Black	100.00		431083.6814	3974295.0538	4.00
5606	Black	190.00		431085.0614	3974296.3851	2.70
5607	Black	175.00		431085.3127	3974296.6670	2.51
5608	Black	290.00		431085.5579	3974297.3516	2.02
5609	Black	100.00		431085.6569	3974297.6352	1.86
5610	Black	40.00		431087.2716	3974293.9422	5.82
5611	Black	25.00		431087.6917	3974293.4921	6.42
5612	Grey	735.00		431086.1103	3974298.2809	1.87

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
5613	Black	35.00		431085.9797	3974297.8136	1.99
5614	Black	85.00		431089.1402	3974296.6804	5.29
5615	Black	40.00		431088.8005	3974295.9979	5.34
5616	Black	40.00		431088.4776	3974300.9897	4.56
5617	Black	30.00		431088.9049	3974300.4131	4.74
5618	Black	60.00		431089.8714	3974299.8572	5.56
5619	Black	80.00		431090.3543	3974299.7771	6.02
5620	Black	15.00		431092.2663	3974298.5765	7.90
5621	Black	50.00		431092.7881	3974298.7110	8.41
5622	Black	170.00		431091.0387	3974301.6382	7.16
5623	Black	10.00		431092.7180	3974302.5873	9.08
5624	Black	210.00		431092.7390	3974301.6696	8.78
5625	Black	15.00		431090.8686	3974296.1762	7.07
5626	Black	55.00		431090.7782	3974295.6090	7.24
5627	Black	50.00		431089.6147	3974301.5270	5.81
5628	Black	25.00		431090.4745	3974301.6995	6.67
5629	Black	70.00		431091.4024	3974299.0367	7.02
5630	Black	30.00		431092.1607	3974298.4652	7.80
5631	Black	30.00		431093.1723	3974295.4059	9.50
5632	Black	45.00		431093.2215	3974294.5608	9.89
5633	Black	100.00		431090.9463	3974293.2224	8.74
5634	Black	70.00		431090.1306	3974293.3136	8.08
5635	Black	70.00		431093.9716	3974292.8253	11.40
5636	Black	85.00		431093.6333	3974292.1013	11.54
5637	Black	60.00		431092.2656	3974291.4137	10.94
5638	Black	85.00		431092.0031	3974291.9979	10.35
5639	Black	120.00		431095.1319	3974290.0639	13.98
5640	Black	25.00		431095.3432	3974289.1205	14.75
5641	Black	50.00		431091.7384	3974290.6655	11.11
5642	Black	46.00		431090.8159	3974290.4233	10.72
5643	Black	30.00		431093.9931	3974290.3856	12.90
5644	Black	15.00		431094.0003	3974290.2369	13.01
5645	Black	280.00		431100.2199	3974287.1357	19.79
5646	Black	225.00		431099.4049	3974289.2814	17.89
5647	Black	20.00		431092.6403	3974291.6711	11.04
5648	Black	15.00		431093.2162	3974291.6315	11.50
5649	Black	90.00		431096.1012	3974285.3284	18.00
5650	Black	90.00		431096.1745	3974284.2262	18.90
5651	Black	115.00		431098.3431	3974294.7362	14.60

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
5652	Black	90.00		431099.0642	3974295.2401	15.16
5653	Black	85.00		431094.6046	3974282.1043	19.74
5654	Black	34.00		431094.1831	3974281.8636	19.74
5655	Black	110.00		431095.9686	3974287.7796	16.13
5656	Black	35.00		431096.0907	3974286.9059	16.83
5657	Black	65.00		431094.0454	3974283.9544	17.88
5658	Black	45.00		431093.8945	3974283.5153	18.17
5659	Black	75.00		431097.8840	3974287.0084	18.06
5660	Black	45.00		431097.5720	3974286.1196	18.43
5661	Black	75.00		431091.4154	3974284.3227	16.27
5662	Black	50.00		431091.4994	3974284.6906	15.98
5663	Black	15.00		431092.7008	3974288.1756	13.65
5664	Black	35.00		431093.0091	3974287.6914	14.22
5665	Black	20.00		431091.6828	3974286.3176	14.63
5666	Black	85.00		431091.8891	3974285.8693	15.12
5667	Black	15.00		431090.0847	3974291.7286	9.24
5668	Black	65.00		431090.0461	3974291.2722	9.58
5669	Black	15.00		431092.1761	3974290.4817	11.54
5670	Black	25.00		431092.6276	3974290.1694	12.08
5671	Black	30.00		431089.1074	3974293.5391	7.22
5672	Black	25.00		431089.3877	3974293.3362	7.56
5673	Black	45.00		431090.5768	3974292.1862	9.21
5674	Black	45.00		431091.2201	3974292.1758	9.66
5675	Black	540.00		431100.2809	3974276.0478	27.92
5676	Black	155.00		431097.2487	3974280.1928	22.78
5677	Black	60.00		431102.3553	3974293.8823	18.69
5678	Black	55.00		431102.5155	3974293.5118	18.95
5679	Black	55.00		431102.7894	3974293.0306	19.35
5680	Black	15.00		431101.0222	3974288.2699	19.80
5681	Black	30.00		431099.4187	3974288.3060	18.45
5682	Black	65.00		431098.7205	3974297.3238	14.44
5683	Black	45.00		431099.1926	3974297.7555	14.86
5684	Black	260.00		431104.4372	3974287.8719	22.93
5685	Black	70.00		431105.6313	3974288.6582	23.63
5686	Black	85.00		431101.5195	3974296.8955	17.27
5687	Black	95.00		431101.8533	3974297.3589	17.55
5688	Black	10.00		431104.4356	3974292.7116	21.02
5689	Black	15.00		431104.9899	3974292.0446	21.75
5690	Black	80.00		431095.1465	3974307.1595	13.51

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
5691	Black	55.00		431095.3282	3974306.4345	13.24
5692	Black	20.00		431107.1297	3974293.5988	23.38
5693	Black	45.00		431105.7204	3974295.6655	21.60
5694	Black	105.00		431100.4159	3974305.2762	17.22
5695	Black	145.00		431101.9541	3974306.0229	18.93
5696	Black	75.00		431092.4129	3974308.9262	12.77
5697	Black	15.00		431093.0128	3974308.6770	12.97
5698	Black	20.00		431096.0413	3974308.6637	15.15
5699	Black	60.00		431096.9639	3974308.9143	16.02
5700	Black	10.00		431089.6814	3974309.4681	11.74
5701	Black	65.00		431090.6345	3974309.9540	12.62
5702	Black	45.00		431091.0338	3974308.4268	11.54
5703	Black	15.00		431090.8221	3974308.8460	11.77
5704	Black	95.00		431076.9937	3974303.0808	8.44
5705	Black	55.00		431077.3513	3974303.5016	8.35
5706	Black	355.00		431082.4760	3974304.6886	6.00
5707	Black	75.00		431082.6986	3974303.8275	5.12
5708	Black	50.00		431075.9097	3974303.4818	9.59
5709	Black	75.00		431076.3809	3974303.6677	9.27
5710	Black	40.00		431079.3267	3974305.4046	8.16
5711	Black	55.00		431079.7036	3974305.4367	7.96
5712	Black	40.00		431077.5147	3974303.7334	8.34
5713	Black	90.00		431077.8870	3974303.9706	8.18
5714	Black	55.00		431077.4153	3974308.7505	11.99
5715	Black	95.00		431077.8283	3974308.3949	11.46
5716	Black	175.00		431083.0381	3974307.4056	8.52
5717	Black	35.00		431082.1258	3974307.0223	8.34
5718	Grey	135.00		431082.7415	3974309.4719	10.61
5719	Black	150.00		431084.2409	3974308.7487	9.76
5720	Black	60.00		431085.3265	3974305.1154	6.19
5721	Black	135.00		431085.0043	3974305.0091	6.05
5722	Black	155.00		431086.1886	3974309.6790	10.84
5723	Black	45.00		431086.8950	3974309.7353	11.03
5724	Black	25.00		431087.3887	3974305.9232	7.55
5725	Black	70.00		431087.0032	3974305.7704	7.27
5726	Black	115.00		431086.6547	3974307.5180	8.82
5727	Black	95.00		431086.9952	3974308.2016	9.57
5728	Grey	75.00		431088.4552	3974307.1880	9.15
5729	Black	75.00		431088.6702	3974306.8724	8.97

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
5730	Black	50.00		431089.2053	3974304.9756	7.68
5731	Grey	95.00		431088.8317	3974304.9641	7.45
5732	Black	55.00		431086.8214	3974310.9102	12.16
5733	Black	80.00		431087.8435	3974311.0539	12.55
5734	Black	25.00		431090.0799	3974306.3653	9.32
5735	Black	40.00		431090.2674	3974306.1869	9.29
5736	Black	40.00		431089.1777	3974309.2040	11.28
5737	Black	60.00		431088.1478	3974310.1734	11.80
5738	Black	90.00		431087.3853	3974303.3277	5.27
5739	Black	40.00		431086.9605	3974303.6152	5.29
5740	Black	30.00		431091.1516	3974307.2909	10.71
5741	Black	50.00		431091.6296	3974307.6764	11.31
5742	Black	30.00		431088.1334	3974303.9346	6.20
5743	Black	30.00		431087.6715	3974303.9759	5.97
5744	Black	35.00		431088.6989	3974306.7673	8.89
5745	Black	35.00		431089.3847	3974306.7457	9.23
5746	Black	25.00		431087.3720	3974303.7148	5.59
5747	Black	30.00		431087.5398	3974304.0027	5.92
5748	Black	30.00		431092.5884	3974305.9208	10.74
5749	Black	45.00		431093.0857	3974306.5439	11.52
5750	Black	40.00		431087.9284	3974302.5695	5.04
5751	Black	15.00		431087.9895	3974302.6500	5.14
5752	Black	40.00		431090.5137	3974314.3184	16.51
5753	Black	40.00		431090.5415	3974314.9622	17.12
5754	Black	80.00		431088.3338	3974300.0009	4.08
5755	Black	55.00		431089.5404	3974298.0371	5.25
5756	Black	50.00		431089.0204	3974311.5136	13.35
5757	Black	70.00		431088.7201	3974312.1400	13.84
5758	Black	95.00		431095.9454	3974296.8785	11.76
5759	Black	65.00		431096.6992	3974300.6857	12.43
5760	Black	35.00		431086.5946	3974307.5605	8.85
5761	Black	145.00		431086.9076	3974308.3806	9.72
5762	Black	40.00		431097.1515	3974297.5294	12.85
5763	Black	25.00		431096.9783	3974297.1509	12.73
5764	Black	25.00		431086.4893	3974307.1192	8.39
5765	Black	60.00		431085.8209	3974307.5156	8.64
5766	Grey	70.00		431101.2754	3974299.0390	16.89
5767	Black	45.00		431100.6638	3974295.7091	16.61
5768	Black	90.00		431085.5824	3974305.9243	7.03

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
5769	Black	25.00		431085.4786	3974306.6705	7.75
5770	Black	35.00		431100.9896	3974296.0907	16.86
5771	Black	25.00		431100.9990	3974295.7223	16.94
5772	Black	30.00		431085.7941	3974304.2111	5.40
5773	Black	80.00		431085.5608	3974304.8024	5.93
5774	Black	25.00		431098.1826	3974293.8070	14.74
5775	Black	50.00		431096.9310	3974293.9995	13.51
5776	Black	40.00		431087.1313	3974305.9893	7.52
5777	Black	100.00		431087.4799	3974305.3404	7.06
5778	Black	15.00		431096.3261	3974294.6297	12.72
5779	Black	25.00		431095.4559	3974294.1972	12.07
5780	Black	15.00		431090.5972	3974305.4913	8.99
5781	Black	35.00		431090.7204	3974304.8358	8.62
5782	Black	25.00		431087.9829	3974305.4149	7.36
5783	Black	50.00		431087.8518	3974305.8146	7.65
5784	Black	100.00		431093.9618	3974293.7731	10.91
5785	Black	25.00		431093.9494	3974294.8817	10.41
5786	Black	25.00		431088.4285	3974303.6022	6.13
5787	Grey	40.00		431088.3350	3974304.0347	6.41
5788	Black	35.00		431089.7965	3974294.3360	7.14
5789	Black	25.00		431089.6994	3974294.1616	7.19
5790	Grey	90.00		431090.5279	3974303.0280	7.35
5791	Black	40.00		431091.0470	3974303.0928	7.83
5792	Black	30.00		431085.2652	3974305.5395	6.60
5793	Black	40.00		431085.7194	3974305.2756	6.42
5794	Black	110.00		431085.5215	3974302.7165	3.89
5795	Black	420.00		431085.3645	3974302.4267	3.57
5796	Black	25.00		431083.6699	3974304.2504	5.30
5797	Black	55.00		431084.2719	3974303.9751	4.98
5798	Black	270.00		431080.9585	3974300.0365	3.58
5799	Black	405.00		431081.4629	3974299.8512	3.04
5800	Grey	60.00		431079.1737	3974302.3919	6.22
5801	Black	50.00		431079.7350	3974302.2909	5.70
5802	Grey	135.00		431079.8753	3974300.9140	4.90
5803	Grey	75.00		431079.6150	3974300.9364	5.15
5804	Grey	150.00		431078.5376	3974301.7348	6.45
5805	Black	45.00		431078.9110	3974302.0789	6.28
5806	Grey	55.00		431081.3243	3974301.3611	3.87
5807	Black	100.00		431081.4576	3974300.9443	3.51

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
5808	Black	55.00		431077.9679	3974301.1616	6.77
5809	Black	55.00		431078.0094	3974301.9594	7.03
5810	Black	40.00		431079.8873	3974301.1988	5.01
5811	Grey	95.00		431080.3518	3974300.7984	4.41
5812	Green	20.00		431077.0864	3974298.3593	7.32
5813	Black	230.00		431077.3132	3974299.1037	7.07
5814	Black	90.00		431080.1666	3974299.5075	4.25
5815	Black	40.00		431080.1836	3974299.0915	4.20
5816	Green	280.00		431075.7920	3974298.6158	8.60
5817	Black	40.00		431075.9302	3974298.8335	8.45
5818	Black	15.00		431075.7841	3974295.0097	9.48
5819	Black	35.00		431074.9660	3974294.9191	10.26
5820	Black	35.00		431078.8268	3974300.5478	5.77
5821	Black	60.00		431079.2083	3974300.4173	5.36
5822	Black	75.00		431072.9029	3974298.9539	11.48
5823	Black	20.00		431073.2127	3974299.5422	11.18
5824	Grey	20.00		431078.1678	3974302.6707	7.22
5825	Grey	40.00		431078.4665	3974302.9887	7.14
5826	Black	25.00		431072.6744	3974302.7473	12.29
5827	Black	45.00		431072.3437	3974303.3355	12.80
5828	Grey	15.00		431080.8126	3974301.7446	4.51
5829	Black	65.00		431081.0964	3974301.7678	4.30
5830	Green	45.00		431070.7001	3974297.9344	13.72
5831	Black	110.00		431070.4323	3974298.8371	13.95
5832	Black	30.00		431075.9427	3974300.8074	8.63
5833	Black	50.00		431066.7393	3974300.1309	17.68
5834	Black	20.00		431069.1480	3974304.8152	16.31
5835	Black	60.00		431070.5198	3974306.8714	15.94
5836	Black	80.00		431070.9214	3974306.6808	15.50
5837	Black	35.00		431068.0701	3974306.3959	17.91
5838	Black	15.00		431067.9264	3974305.7531	17.79
5839	Black	30.00		431069.7485	3974308.3642	17.38
5840	Black	25.00		431070.4271	3974308.5222	16.90
5841	Black	35.00		431065.5828	3974306.7498	20.34
5842	Black	30.00		431069.4949	3974308.8742	17.87
5843	Black	45.00		431070.7767	3974309.6390	17.27
5844	Black	110.00		431066.5123	3974310.7095	21.37
5845	Black	60.00		431067.4453	3974311.4728	21.04
5846	Black	125.00		431072.1501	3974315.1537	20.27

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
5847	Black	65.00		431073.6715	3974309.8637	15.26
5848	Black	5.00		431069.6119	3974311.9559	19.65
5849	Black	5.00		431070.3355	3974312.1748	19.26
5850	Black	85.00		431075.1727	3974312.1205	16.03
5851	Black	25.00		431076.7904	3974309.4544	12.92
5852	Black	45.00		431073.5568	3974308.6206	14.49
5853	Black	25.00		431073.1765	3974308.3685	14.61
5854	Black	80.00		431083.3925	3974320.3841	21.41
5855	Black	150.00		431083.6713	3974320.9499	21.97
5856	Black	25.00		431071.9409	3974307.9805	15.35
5857	Black	20.00		431070.1010	3974306.7671	16.26
5858	Black	110.00		431082.0150	3974317.8471	19.00
5859	Black	125.00		431083.8721	3974314.8820	15.90
5860	Black	20.00		431074.2403	3974306.3441	12.52
5861	Black	20.00		431074.9527	3974306.0498	11.78
5862	Black	75.00		431085.2421	3974318.5970	19.62
5863	Black	15.00		431084.9382	3974317.7545	18.77
5864	Black	35.00		431076.0993	3974307.4865	11.86
5865	Black	20.00		431086.7270	3974318.3069	19.45
5866	Black	15.00		431087.0639	3974319.0259	20.21
5867	Black	40.00		431081.5361	3974311.6241	12.95
5868	Black	30.00		431080.1198	3974311.5793	13.29
5869	Black	105.00		431088.0356	3974320.4142	21.73
5870	Black	95.00		431088.0175	3974319.6636	20.99
5871	Black	10.00		431086.0308	3974313.5266	14.63
5872	Black	10.00		431085.5514	3974312.1633	13.22
5873	Black	5.00		431087.1473	3974320.0866	21.27
5874	Black	40.00		431087.3824	3974320.1006	21.32
5875	Black	25.00		431087.3952	3974320.1184	21.34
5876	Black	25.00		431091.1426	3974319.2059	21.31
5877	Black	25.00		431091.5950	3974319.4010	21.64
5878	Black	45.00		431078.5701	3974321.3187	23.07
5879	Black	15.00		431076.2274	3974321.6881	24.11
5880	Black	65.00		431086.1339	3974323.6396	24.71
5881	Black	35.00		431086.4568	3974322.6950	23.79
5882	Black	55.00		431077.0432	3974322.6233	24.74
5883	Black	10.00		431077.9012	3974322.3170	24.21
5884	Black	20.00		431081.9305	3974325.4381	26.56
5885	Black	75.00		431080.0159	3974325.6603	27.02

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
5886	Black	70.00		431083.0833	3974330.5537	31.59
5887	Black	50.00		431084.1126	3974331.0632	32.07
5888	Black	75.00		431082.1867	3974326.2407	27.33
5889	Black	10.00		431084.9629	3974327.3567	28.37
5890	Black	10.00		431087.2236	3974329.5303	30.67
5891	Black	15.00		431087.6176	3974329.2905	30.47
5892	Black	55.00		431090.1827	3974327.5094	29.10
5893	Black	40.00		431090.4602	3974327.2972	28.95
5894	Black	35.00		431095.9871	3974325.5672	29.00
5895	Black	110.00		431096.6088	3974320.3705	24.63
5896	Black	5.00		431093.1193	3974326.6319	28.99
5897	Black	10.00		431093.4050	3974326.0408	28.51
5898	Black	50.00		431097.7014	3974320.3240	25.15
5899	Black	90.00		431098.9972	3974319.3095	25.03
5900	Black	55.00		431096.8380	3974318.7179	23.33
5901	Black	95.00		431097.4747	3974318.2815	23.31
5902	Black	35.00		431099.9435	3974321.1691	27.09
5903	Black	40.00		431100.7077	3974319.8910	26.52
5904	Black	45.00		431095.7249	3974316.2168	20.62
5905	Black	65.00		431095.3333	3974315.0252	19.42
5906	Black	45.00		431109.5081	3974312.8549	28.70
5907	Black	25.00		431107.7045	3974312.3343	26.87
5908	Black	35.00		431095.9786	3974312.3189	17.67
5909	Black	35.00		431095.0939	3974312.3723	17.14
5910	Black	90.00		431106.5330	3974317.0710	28.59
5911	Black	20.50		431107.7174	3974315.4650	28.56
5912	Black	58.00		431107.0612	3974310.8733	25.60
5913	Black	44.00		431106.2841	3974308.1059	23.72
5914	Black	23.00		431106.8507	3974312.8677	26.41
5915	Black	15.70		431106.8100	3974317.6645	29.18
5916	Black	9.00		431106.7316	3974306.2032	23.48
5917	Black	22.60		431107.0507	3974305.6694	23.63
5918	Black	20.00		431104.6789	3974304.9743	21.16
5919	Black	18.70		431104.8286	3974302.9278	20.82
5920	Black	42.40		431108.0102	3974303.6325	24.08
5921	Black	6.00		431106.6375	3974306.2855	23.42
5922	Black	32.00		431113.3735	3974307.8013	30.30
5923	Black	13.00		431099.5736	3974319.1413	25.23
5924	Black	9.00		431098.9477	3974320.6111	26.07

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
5925	Black	8.80		431097.8199	3974320.7076	25.54
5926	Black	7.00		431097.3151	3974321.1304	25.64
5927	Black	8.00		431097.1879	3974321.5110	25.90
5928	Black	13.00		431095.3631	3974320.7190	24.34
5929	Black	8.00		431094.7406	3974320.4251	23.80
5930	Black	5.00		431094.4763	3974320.8782	24.10
5931	Black	8.00		431090.1461	3974322.5995	24.30
5932	Black	11.00		431086.4732	3974326.3134	27.40
5933	Black	9.20		431091.7850	3974323.5437	25.64
5934	Black	11.50		431091.6764	3974324.3780	26.41
5935	Black	8.40		431091.5609	3974323.7300	25.76
5936	Black	9.00		431089.3146	3974317.1658	18.83
5937	Black	22.40		431089.4796	3974316.6832	18.41
5938	Black	23.00		431090.3724	3974316.5937	18.59
5939	Black	27.00		431091.2629	3974316.3138	18.64
5940	Black	5.90		431091.6937	3974315.9010	18.42
5941	Black	12.50		431092.0756	3974315.7487	18.44
5942	Black	8.50		431092.2832	3974315.2924	18.11
5943	Black	10.50		431094.4637	3974317.9409	21.46
5944	Black	7.00		431092.3214	3974318.5765	21.13
5945	Black	10.80		431091.8413	3974317.3289	19.79
5946	Black	7.40		431091.2807	3974317.0381	19.32
5947	Black	6.00		431092.5039	3974317.3224	20.05
5948	Black	10.00		431090.1575	3974317.0101	18.92
5949	Black	8.00		431088.8712	3974315.3526	16.96
5950	Black	15.20		431087.7029	3974316.4789	17.80
5951	Black	11.70		431089.2193	3974314.6062	16.34
5952	Black	19.80		431087.2486	3974314.0837	15.36
5953	Black	10.40		431088.1267	3974314.0533	15.52
5954	Black	21.00		431087.4194	3974313.1858	14.51
5955	Black	23.30		431083.1648	3974314.7315	15.78
5956	Black	12.00		431083.2779	3974314.5321	15.58
5957	Black	12.50		431083.6483	3974315.6024	16.62
5958	Black	13.60		431083.1009	3974316.1722	17.23
5959	Black	11.00		431082.0833	3974315.8579	17.02
5960	Black	11.00		431084.5081	3974312.9820	13.99
5961	Black	5.60		431084.3551	3974313.1659	14.17
5962	Black	7.50		431084.1966	3974315.8453	16.85
5963	Black	9.00		431083.2826	3974314.4418	15.49

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
5964	Black	5.00		431084.7990	3974314.0072	15.02
5965	Black	11.70		431084.6901	3974310.1722	11.18
5966	Black	12.00		431084.9647	3974310.0130	11.03
5967	Black	21.90		431086.0566	3974310.4072	11.54
5968	Black	12.00		431086.0665	3974310.8657	11.99
5969	Black	5.90		431086.1922	3974311.8138	12.95
5970	Black	11.70		431087.5657	3974313.2305	14.59
5971	Black	5.00		431087.5108	3974313.0897	14.44
5972	Black	5.00		431088.0514	3974312.0004	13.51
5973	Black	4.00		431088.0850	3974309.7323	11.36
5974	Black	14.00		431088.5622	3974310.3168	12.07
5975	Black	9.00		431088.5969	3974310.2655	12.03
5976	Black	13.00		431089.0874	3974309.8024	11.79
5977	Black	8.00		431089.2917	3974309.4567	11.56
5978	Black	7.60		431089.1344	3974309.1310	11.20
5979	Black	9.00		431089.4249	3974310.0925	12.19
5980	Black	11.00		431089.8209	3974308.6948	11.12
5981	Black	5.00		431089.6062	3974309.5883	11.81
5982	Black	7.40		431089.4753	3974310.8693	12.92
5983	Black	8.00		431089.7804	3974310.9295	13.10
5984	Black	6.00		431082.1133	3974314.2634	15.44
5985	Black	12.00		431080.0395	3974314.6851	16.28
5986	Black	8.00		431080.2599	3974312.1042	13.74
5987	Black	6.80		431081.2402	3974312.5333	13.90
5988	Black	12.00		431082.0894	3974311.9164	13.12
5989	Black	9.00		431082.1434	3974311.1292	12.34
5990	Black	9.80		431082.3109	3974311.9538	13.12
5991	Black	8.00		431083.5407	3974310.0278	11.07
5992	Black	25.00		431085.0785	3974308.2385	9.27
5993	Black	595.00		431081.8107	3974298.7846	2.58
5994	Black	915.00		431082.1583	3974298.4482	2.29
5995	Black	6.30		431102.3535	3974351.4552	55.45
5996	Black	4.60		431104.9753	3974353.3433	58.12
5997	Black	6.50		431102.9253	3974356.3863	60.31
5998	Grey	9.80		431091.6900	3974349.5179	51.05
5999	Grey	8.60		431089.2335	3974347.4855	48.73
6000	Black	5.00		431091.2782	3974353.9047	55.34
6001	Grey	21.20		431097.6159	3974358.9517	61.40
6002	Black	5.40		431101.3165	3974357.7186	61.12

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
6003	Black	5.50		431105.0989	3974356.4546	61.08
6004	Black	24.20		431105.0717	3974351.4832	56.42
6005	Black	9.00		431104.5269	3974351.3001	56.05
6006	Black	9.30		431102.4752	3974350.8332	54.91
6007	Grey	4.20		431096.3103	3974354.8908	57.16
6008	Black	216.30		431101.2496	3974349.3960	53.15
6009	Black	8.70		431103.2504	3974350.3816	54.74
6010	Black	4.60		431103.3474	3974349.1876	53.66
6011	Black	6.70		431104.3104	3974349.6954	54.48
6012	Black	11.10		431108.3890	3974349.6532	56.06
6013	Black	2.00		431109.5724	3974350.7184	57.53
6014	Black	4.10		431110.0881	3974350.9877	58.00
6015	Black	6.60		431105.7727	3974347.4134	52.93
6016	Black	5.40		431103.9652	3974347.2523	52.08
6017	Black	14.60		431109.5319	3974346.8662	54.08
6018	Black	24.10		431104.8935	3974345.8929	51.19
6019	Black	10.50		431112.4979	3974346.6240	55.31
6020	Black	10.40		431113.5052	3974347.6309	56.69
6021	Red	3.70		431112.6786	3974348.4258	56.96
6022	Black	7.90		431105.1835	3974343.4214	49.06
6023	Black	4.90		431106.7325	3974343.4023	49.72
6024	Black	5.60		431108.0206	3974342.7909	49.77
6025	Black	6.80		431108.4491	3974343.4340	50.54
6026	Black	5.80		431109.3160	3974341.0785	48.92
6027	Black	5.10		431111.5812	3974344.0889	52.66
6028	Black	4.00		431111.7828	3974344.4825	53.10
6029	Black	4.30		431111.4644	3974344.9512	53.34
6030	Black	7.50		431114.5619	3974344.9310	54.96
6031	Black	46.10		431115.0993	3974345.2002	55.49
6032	Black	7.10		431110.4673	3974341.9244	50.23
6033	Black	11.40		431111.1826	3974339.8342	48.85
6034	Black	12.60		431114.3750	3974340.9684	51.59
6035	Red	5.20		431114.9438	3974341.5281	52.38
6036	Black	29.70		431117.8428	3974341.9915	54.48
6037	Black	8.50		431117.6627	3974340.6006	53.28
6038	Black	50.80		431117.2836	3974339.7184	52.35
6039	Black	8.50		431117.2034	3974338.6335	51.46
6040	Black	49.80		431116.3784	3974338.7124	51.00
6041	Black	4.70		431115.6181	3974340.4674	51.92

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
6042	Black	5.50		431115.2965	3974338.3673	50.06
6043	Black	3.80		431113.6798	3974339.2227	49.77
6044	Grey	20.30		431113.1112	3974338.2777	48.67
6045	Black	27.60		431109.5672	3974338.1025	46.52
6046	Black	4.00		431109.1641	3974338.1175	46.31
6047	Grey	5.00		431109.4619	3974337.2372	45.73
6048	Black	9.40		431111.9110	3974335.0495	45.36
6049	Black	109.90		431111.3544	3974333.9327	44.14
6050	Red	8.10		431114.1207	3974337.2977	48.49
6051	Black	96.00		431116.6456	3974337.4933	50.23
6052	Black	37.70		431117.5566	3974337.4240	50.77
6053	Black	21.90		431117.7780	3974337.2953	50.82
6054	Black	21.20		431113.5581	3974332.9077	44.74
6055	Black	53.10		431114.5803	3974332.7971	45.33
6056	Black	5.70		431115.2582	3974336.0444	48.23
6057	Red	10.90		431119.8900	3974340.1866	54.38
6058	Black	7.80		431121.2667	3974340.7351	55.70
6059	Red	10.30		431122.1672	3974341.3340	56.75
6060	Black	11.50		431120.5886	3974339.2896	54.17
6061	Black	13.20		431121.1626	3974338.5427	54.01
6062	Black	29.70		431122.4136	3974337.1545	53.88
6063	Black	3.00		431120.8581	3974337.3292	52.92
6064	Black	5.10		431120.1638	3974338.1815	53.07
6065	Black	10.10		431117.9968	3974335.4608	49.60
6066	Black	7.20		431119.2931	3974335.0566	50.19
6067	Black	11.30		431121.5150	3974334.9581	51.69
6068	Red	5.70		431121.7097	3974333.9158	51.12
6069	Black	10.10		431121.2649	3974333.6284	50.60
6070	Black	6.90		431121.6522	3974333.7653	50.97
6071	Black	31.50		431124.7316	3974335.2597	54.25
6072	Red	3.90		431124.1452	3974336.5987	54.73
6073	Red	4.80		431124.0970	3974337.6787	55.44
6074	Black	7.80		431124.0912	3974339.1620	56.48
6075	Black	7.40		431114.1090	3974330.7417	43.49
6076	Black	35.50		431116.6899	3974333.6438	47.38
6077	Red	6.30		431115.4617	3974333.6730	46.57
6078	Black	6.40		431115.6766	3974330.6437	44.51
6079	Black	3.90		431115.8849	3974329.3144	43.72
6080	Red	5.90		431117.9275	3974330.4321	45.98

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
6081	Black	5.50		431118.4148	3974332.7224	47.92
6082	Black	4.10		431127.0402	3974337.9124	57.74
6083	Red	12.10		431119.4821	3974329.1667	46.29
6084	Black	5.30		431118.9197	3974328.5651	45.47
6085	Black	11.20		431119.2360	3974326.1716	44.20
6086	Black	93.50		431123.4092	3974327.9652	48.61
6087	Black	6.90		431123.2452	3974328.6545	48.89
6088	Black	8.90		431123.8384	3974329.0586	49.61
6089	Black	103.10		431123.6359	3974329.5450	49.74
6090	Black	7.00		431124.2257	3974331.1577	51.21
6091	Black	3.60		431127.2185	3974332.7139	54.52
6092	Black	21.30		431127.9090	3974332.2047	54.75
6093	Black	6.00		431128.6797	3974334.8995	57.02
6094	Black	7.30		431130.3050	3974334.0778	57.79
6095	Red	17.20		431131.0651	3974333.4922	58.05
6096	Black	8.40		431131.1681	3974331.4245	56.93
6097	Black	15.20		431129.1218	3974330.6627	54.81
6098	Red	11.20		431127.8991	3974328.7896	52.74
6099	Black	6.10		431126.5346	3974326.8724	50.54
6100	Black	5.10		431123.6742	3974325.8182	47.58
6101	Grey	20.50		431125.8368	3974323.9476	48.39
6102	Black	5.20		431129.1174	3974325.3787	51.94
6103	Red	4.80		431132.9584	3974330.6691	57.99
6104	Black	4.40		431129.6820	3974323.0022	51.27
6105	Red	6.80		431134.7153	3974323.7500	56.09
6106	Black	11.90		431135.8641	3974322.6890	56.67
6107	Red	5.50		431131.7805	3974319.7340	51.74
6108	Black	4.40		431131.9485	3974317.6468	51.09
6109	Red	92.70		431138.1628	3974317.6591	56.93
6110	Red	7.20		431136.9446	3974316.1869	55.30
6111	Black	98.70		431133.6582	3974310.4000	50.58
6112	Black	25.30		431137.3360	3974309.9477	54.08
6113	Red	15.20		431129.8332	3974308.5326	46.44
6114	Grey	32.80		431130.1056	3974298.7324	45.73
6115	Grey	9.40		431142.8319	3974294.2911	58.64
6116	Yellow	114.80		431131.3649	3974287.2944	48.42
6117	Yellow	2.30		431136.2807	3974285.4888	53.63
6118	Yellow	5.30		431131.9078	3974282.6092	50.27
6119	Yellow	17.30		431145.0736	3974286.4914	61.97

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
6120	Yellow	13.50		431143.8124	3974287.3664	60.56
6121	Yellow	14.50		431143.2940	3974283.9869	60.79
6122	Grey	19.70		431141.0172	3974278.8228	60.12
6123	Yellow	14.40		431137.2181	3974276.3465	57.49
6124	Yellow	9.10		431140.9649	3974278.2469	60.27
6125	Yellow	3.30		431135.1258	3974269.8375	58.52
6126	Yellow	10.10		431132.2306	3974274.2467	53.87
6127	Yellow	4.10		431132.5918	3974273.4815	54.55
6128	Yellow	21.40		431136.6731	3974269.2966	60.14
6129	Yellow	14.80		431133.6612	3974269.9635	57.20
6130	Yellow	7.10		431129.5723	3974267.6691	54.99
6131	Yellow	31.70		431130.6740	3974267.7269	55.86
6132	Yellow	74.90		431133.3854	3974263.7584	60.36
6133	Yellow	5.00		431131.1503	3974263.6620	58.62
6134	Grey	5.60		431135.7923	3974263.8565	62.27
6135	Yellow	8.60		431130.2060	3974264.4212	57.40
6136	Yellow	3.10		431131.6478	3974264.6424	58.43
6137	Yellow	6.40		431134.2497	3974263.4741	61.23
6138	Yellow	6.90		431134.8384	3974261.3976	62.92
6139	Yellow	5.40		431131.6910	3974260.9670	60.70
6140	Yellow	10.10		431134.6459	3974262.6280	62.04
6141	Yellow	53.40		431129.5700	3974262.7796	57.91
6142	Yellow	6.20		431129.0249	3974263.5615	57.00
6143	Yellow	71.90		431128.6120	3974262.8747	57.11
6144	Yellow	45.90		431133.7888	3974261.0320	62.31
6145	Yellow	5.90		431134.1768	3974259.5524	63.52
6146	Yellow	10.50		431127.3269	3974260.2145	57.86
6147	Yellow	4.90		431131.7872	3974257.8864	62.75
6148	Yellow	6.00		431132.6341	3974257.4338	63.68
6149	Yellow	8.30		431127.3996	3974258.8242	58.86
6150	Yellow	7.00		431125.1637	3974259.4496	56.81
6151	Yellow	5.30		431124.9648	3974258.2816	57.49
6152	Yellow	19.70		431127.4370	3974257.6032	59.72
6153	Yellow	4.20		431129.7874	3974255.3476	62.98
6154	Yellow	9.90		431130.6877	3974256.4736	62.87
6155	Yellow	5.50		431123.5374	3974257.9465	56.73
6156	Yellow	5.00		431129.7897	3974254.4105	63.64
6157	Yellow	19.40		431130.3446	3974254.1288	64.23
6158	Yellow	6.60		431130.2822	3974254.2273	64.12

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
6159	Yellow	502.10	cp844	431124.3043	3974249.5238	63.57
6160	Yellow	9.90		431120.8289	3974252.9265	58.74
6161	Yellow	51.70		431120.1496	3974254.4035	57.16
6162	Yellow	24.40		431119.5288	3974253.4214	57.55
6163	Yellow	4.60		431119.3112	3974253.5710	57.30
6164	Yellow	185.80		431120.2170	3974250.1955	60.54
6165	Yellow	9.20		431120.6887	3974250.2676	60.77
6166	Yellow	7.30		431120.9583	3974250.9047	60.42
6167	Yellow	8.00		431123.6379	3974249.5821	63.11
6168	Yellow	114.20		431122.7944	3974247.7017	64.08
6169	Yellow	15.20		431124.0580	3974248.1691	64.48
6170	Yellow	14.80		431118.3334	3974249.1681	60.29
6171	Yellow	21.00		431117.5524	3974250.1695	59.03
6172	Yellow	5.40		431115.6687	3974249.9626	58.16
6173	Yellow	11.60		431119.5460	3974246.4336	63.24
6174	Yellow	5.60		431119.6581	3974246.8363	62.97
6175	Yellow	4.60		431117.1246	3974249.0077	59.76
6176	Red	4.10		431118.8555	3974247.1071	62.30
6177	Yellow	7.70		431117.0600	3974246.7985	61.58
6178	Yellow	194.10		431111.5971	3974246.2516	59.35
6179	Yellow	33.60		431111.2221	3974251.8820	54.22
6180	Red	7.40		431102.5711	3974243.4443	58.45
6181	Yellow	26.50		431107.1930	3974252.5282	51.76
6182	Red	35.70		431099.3302	3974248.9050	52.27
6183	Yellow	32.30		431095.1180	3974252.9060	47.32
6184	Red	5.50		431091.3198	3974252.2388	47.27
6185	Red	6.00		431080.6473	3974245.7081	53.42
6186	Red	7.80		431078.1483	3974242.0709	57.26
6187	Grey	10.00		431073.9380	3974244.2356	55.75
6188	Grey	9.00		431073.2635	3974255.2712	45.11
6189	Red	20.60		431060.5443	3974252.7146	52.06
6190	Red	12.10		431058.8208	3974248.8445	56.29
6191	Red	11.70		431060.1307	3974255.8660	49.48
6192	Red	3.40		431057.4756	3974255.9723	50.74
6193	Grey	14.60		431057.1258	3974255.9489	50.95
6194	Grey	10.80		431056.7535	3974253.0799	53.59
6195	Red	11.90		431056.7908	3974257.8795	49.51
6196	Red	5.30		431056.7196	3974256.5792	50.64
6197	Red	9.30		431055.6129	3974256.5332	51.29

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
6198	Red	5.00		431055.6650	3974252.7077	54.47
6199	Other	63.00	rebar	431056.2637	3974245.9420	60.04
6200	Red	6.80		431054.7728	3974258.1626	50.44
6201	Red	35.90		431053.2216	3974260.0017	49.91
6202	Grey	4.20		431053.1387	3974259.0215	50.73
6203	Red	6.90		431051.7282	3974254.8016	54.95
6204	Red	6.70		431051.9986	3974252.9699	56.27
6205	Red	4.40		431051.1013	3974251.0666	58.35
6206	Red	25.00		431049.7468	3974259.5581	52.49
6207	Red	5.50		431048.6419	3974259.8037	53.04
6208	Grey	6.60		431048.2714	3974258.9258	53.94
6209	Red	11.40		431047.9501	3974258.8466	54.21
6210	Grey	6.30		431048.5386	3974258.3626	54.18
6211	Red	4.50		431048.3098	3974258.6988	54.08
6212	Red	21.60		431047.0522	3974260.6509	53.51
6213	Red	8.30		431047.3144	3974259.0321	54.51
6214	Red	33.50		431046.5914	3974259.2232	54.86
6215	Red	7.80		431046.9731	3974257.8306	55.62
6216	Grey	200.60		431045.6813	3974257.9345	56.42
6217	Red	12.90		431048.7658	3974257.7830	54.47
6218	Red	39.70		431044.7507	3974253.7883	60.12
6219	Red	7.00		431046.7378	3974253.1361	59.33
6220	Red	6.40		431046.8576	3974253.9757	58.61
6221	Red	7.80		431043.7361	3974254.9539	59.93
6222	Red	7.60		431047.6031	3974256.9278	55.88
6223	Grey	7.30		431045.1810	3974259.1890	55.87
6224	Red	5.80		431045.1999	3974258.0662	56.66
6225	Red	64.50		431041.8341	3974257.1569	59.67
6226	Red	12.10		431041.7296	3974256.5843	60.15
6227	Red	11.80		431042.9256	3974261.0179	56.22
6228	Red	14.20		431043.4000	3974261.7074	55.41
6229	Red	6.30		431043.8032	3974262.5830	54.52
6230	Red	11.40		431043.0605	3974262.8513	54.90
6231	Red	18.20		431038.8395	3974264.3324	57.23
6232	Red	6.90		431038.2813	3974259.3240	60.82
6233	Red	29.50		431038.2297	3974261.7614	59.30
6234	Red	74.70		431039.6999	3974267.5936	54.61
6235	Red	22.40		431036.6854	3974268.2809	56.73
6236	Red	5.10		431040.5822	3974269.8410	52.61

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
6237	Red	4.50		431035.7612	3974267.2124	58.09
6238	Red	16.20		431036.7181	3974266.7140	57.57
6239	Red	89.20		431032.0063	3974267.2102	61.26
6240	Red	61.40		431032.3700	3974271.9492	58.62
6241	Green	13.10		431036.0441	3974306.1385	48.86
6242	Green	19.90		431038.2162	3974310.7789	47.65
6243	Green	4.40		431038.5070	3974311.8589	47.64
6244	Black	5.10		431033.5864	3974314.4753	53.10
6245	Black	5.20		431030.0360	3974316.3131	57.04
6246	Black	9.20		431031.5106	3974316.4364	55.67
6247	Black	3.40		431030.3638	3974314.8554	56.30
6248	Green	6.80		431032.2701	3974314.1162	54.26
6249	Black	3.70		431031.4721	3974316.1386	55.62
6250	Green	4.60		431033.6204	3974313.3509	52.75
6251	Green	6.40		431033.8046	3974312.3997	52.32
6252	Green	8.50		431028.9791	3974313.3227	57.22
6253	Green	5.10		431034.1458	3974315.7031	52.94
6254	Green	30.90		431042.1973	3974314.0908	44.80
6255	Green	9.50		431042.7533	3974313.0363	43.93
6256	Green	9.80		431042.6571	3974312.1384	43.75
6257	Green	4.30		431039.9895	3974316.2630	47.63
6258	Green	10.00		431038.9321	3974315.9716	48.52
6259	Green	10.30		431037.9034	3974316.2279	49.57
6260	Green	10.70		431041.8326	3974318.3251	46.73
6261	Green	18.50		431042.2352	3974317.9999	46.23
6262	Green	8.60		431041.2639	3974320.1719	48.04
6263	Green	6.20		431037.8689	3974321.8334	51.82
6264	Black	18.30		431045.8776	3974324.5257	46.20
6265	Green	9.70		431042.8138	3974329.1439	51.35
6266	Green	13.10		431047.3157	3974328.3598	47.29
6267	Green	7.70		431048.5288	3974328.5589	46.47
6268	Green	5.40		431048.6388	3974327.8490	45.94
6269	Black	6.70		431047.4524	3974329.3682	47.82
6270	Green	217.60	cp848	431044.6471	3974331.1644	51.12
6271	Green	15.70		431042.2329	3974331.8674	53.45
6272	Green	53.10		431051.1754	3974330.3668	45.68
6273	Black	7.30		431053.6002	3974329.4283	43.29
6274	Green	22.80		431046.2806	3974331.5472	50.11
6275	Green	5.50		431047.2690	3974332.6656	50.11

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
6276	Grey	7.70		431050.6256	3974329.9867	45.83
6277	Black	20.10		431054.7609	3974332.8172	44.96
6278	Black	8.20		431055.4925	3974333.1353	44.72
6279	Green	14.90		431047.9544	3974337.5897	53.07
6280	Black	17.50		431056.7480	3974336.6822	46.73
6281	Black	8.60		431057.5538	3974335.3902	45.21
6282	Black	24.90		431057.1764	3974338.2596	47.77
6283	Green	60.50		431061.1807	3974333.2386	41.36
6284	Green	8.20		431053.0790	3974339.3650	51.08
6285	Black	18.40		431064.1545	3974340.8765	46.51
6286	Green	4.60		431061.1597	3974342.0656	48.93
6287	Black	7.50		431063.3785	3974336.4675	42.96
6288	Black	4.80		431065.6984	3974338.6706	43.85
6289	Red	10.10		431067.6034	3974340.6870	44.94
6290	Grey	8.50		431062.3347	3974345.2578	51.25
6291	Black	5.00		431071.8288	3974338.0152	40.99
6292	Black	38.00		431073.4059	3974340.0762	42.52
6293	Black	4.70		431075.3177	3974338.4422	40.48
6294	Black	8.10		431077.2963	3974341.0544	42.65
6295	Black	11.10		431077.2234	3974340.8309	42.44
6296	Black	4.50		431077.7832	3974341.6927	43.21
6297	Black	26.60		431078.1081	3974338.6325	40.13
6298	Black	21.60		431079.0634	3974335.4278	36.82
6299	Black	18.90		431076.1715	3974334.5184	36.46
6300	Black	89.90		431079.5241	3974332.5419	33.90
6301	Black	9.30		431080.9683	3974336.4241	37.59
6302	Black	7.50		431080.4837	3974335.9896	37.20
6303	Black	13.90		431082.4953	3974335.7219	36.78
6304	Black	81.80		431082.1732	3974337.2641	38.33
6305	Yellow	6.40		431082.4617	3974336.7899	37.84
6306	Black	4.10		431082.1085	3974338.9953	40.07
6307	Yellow	7.20		431079.9930	3974336.1841	37.45
6308	Black	7.20		431084.4091	3974337.4417	38.45
6309	Black	5.00		431083.4802	3974341.3545	42.37
6310	Black	5.60		431089.5547	3974340.5398	41.87
6311	Grey	4.80		431089.3838	3974343.1850	44.47
6312	Black	5.20		431095.3306	3974346.7274	48.97
6313	Black	4.10		431099.1396	3974348.8770	52.02
6314	Black	20.50		431099.1835	3974345.3824	48.69

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
6315	Grey	9.10		431099.8909	3974346.3588	49.84
6316	Black	12.80		431101.1606	3974347.8092	51.62
6317	Black	29.20		431099.2805	3974342.9113	46.38
6318	Black	4.90		431098.7937	3974343.2213	46.52
6319	Black	22.40		431106.1297	3974342.3656	48.52
6320	Black	6.70		431107.0302	3974340.5150	47.30
6321	Black	4.20		431102.6255	3974340.3898	45.24
6322	Grey	37.90		431101.2030	3974338.0851	42.56
6323	Black	7.50		431099.1439	3974337.5263	41.26
6324	Grey	5.80		431098.2739	3974342.5158	45.69
6325	Black	15.10		431096.7713	3974341.7688	44.53
6326	Black	6.40		431097.7654	3974341.6234	44.68
6327	Black	368.60		431095.9963	3974336.4199	39.19
6328	Black	5.60		431095.4545	3974338.3758	40.91
6329	Black	17.40		431094.8712	3974338.0929	40.48
6330	Black	147.80		431093.0378	3974338.3077	40.26
6331	Black	70.40		431092.3316	3974340.0487	41.82
6332	Black	6.50		431092.2140	3974340.2820	42.02
6333	Black	36.50		431091.4492	3974339.3371	40.96
6334	Black	36.30		431094.3370	3974334.5717	36.94
6335	Black	12.70		431090.0738	3974336.2235	37.66
6336	Black	8.00		431091.4518	3974336.8524	38.51
6337	Black	27.70		431091.1833	3974338.3931	39.98
6338	Grey	15.00		431091.2148	3974337.8002	39.40
6339	Black	4.30		431092.9004	3974339.3862	41.28
6340	Black	7.50		431088.7329	3974338.9504	40.19
6341	Black	3.30		431090.2692	3974337.8231	39.27
6342	Black	84.00		431090.8864	3974333.4876	35.10
6343	Black	199.50		431105.0775	3974337.4771	43.70
6344	Black	572.00		431105.0616	3974337.8311	44.00
6345	Black	59.70		431102.7412	3974337.0767	42.28
6346	Black	9.70		431102.9567	3974338.1454	43.33
6347	Grey	4.80		431101.7028	3974337.9624	42.64
6348	Black	5.20		431104.3998	3974336.0829	42.15
6349	Black	54.00		431106.2670	3974333.5820	40.93
6350	Black	3.90		431104.6052	3974333.0556	39.61
6351	Black	26.10		431105.5194	3974333.2015	40.21
6352	Black	36.80		431107.9793	3974332.6264	41.09
6353	Black	7.00		431101.9245	3974334.0588	39.21

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
6354	Black	15.30		431100.9131	3974334.0840	38.79
6355	Black	4.90		431101.5025	3974334.8950	39.77
6356	Grey	9.20		431101.6158	3974332.8939	38.03
6357	Black	4.40		431101.3055	3974334.7841	39.59
6358	Black	4.70		431100.3817	3974333.1376	37.71
6359	Black	16.00		431097.0422	3974332.3254	35.65
6360	Black	30.70		431099.5886	3974330.1716	34.69
6361	Black	8.80		431094.4816	3974331.0413	33.60
6362	Black	5.40		431094.2099	3974330.1084	32.63
6363	Black	5.00		431095.4116	3974329.8548	32.77
6364	Black	13.80		431095.9299	3974329.6649	32.77
6365	Black	7.30		431096.3309	3974328.5624	31.89
6366	Black	14.80		431095.7718	3974327.2545	30.47
6367	Black	6.10		431098.8084	3974328.1679	32.55
6368	Grey	10.60		431099.2248	3974325.7683	30.61
6369	Grey	18.70		431100.2630	3974326.2300	31.53
6370	Black	72.80		431101.6849	3974327.0294	32.95
6371	Black	16.80		431100.7878	3974325.2297	30.94
6372	Black	22.00		431101.5987	3974329.7260	35.23
6373	Black	21.00		431102.9760	3974329.4313	35.67
6374	Black	5.10		431102.8385	3974329.5018	35.66
6375	Black	5.20		431102.6484	3974330.0505	36.03
6376	Grey	5.70		431101.5590	3974332.9324	38.04
6377	Black	4.20		431103.4826	3974333.3782	39.33
6378	Black	6.20		431104.2122	3974331.1084	37.74
6379	Black	57.00		431106.7794	3974330.0928	38.33
6380	Yellow	9.70		431106.4841	3974331.0146	38.91
6381	Black	7.00		431108.4629	3974332.9964	41.67
6382	Black	7.20		431111.3238	3974331.7811	42.44
6383	Black	70.80		431102.8789	3974327.5136	33.99
6384	Black	68.10		431104.2099	3974326.6733	34.05
6385	Red	16.50		431103.6700	3974325.1548	32.50
6386	Black	4.40		431104.7632	3974328.7562	36.07
6387	Black	5.00		431101.0224	3974324.4567	30.42
6388	Black	72.00		431100.5419	3974323.7273	29.54
6389	Black	31.40		431105.9607	3974323.9195	32.97
6390	Black	33.90		431104.5195	3974321.3149	30.06
6391	Red	11.40		431105.0463	3974323.5426	32.09
6392	Grey	120.00		431105.3878	3974322.1960	31.30

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
6393	Black	8.00		431107.5110	3974321.2019	32.07
6394	Red	11.34		431104.9521	3974325.1119	33.25
6395	Black	9.30		431106.2435	3974327.0924	35.60
6396	Black	7.80		431106.6158	3974328.8159	37.20
6397	Black	13.20		431112.8813	3974328.3215	40.89
6398	Black	30.30		431113.9209	3974328.4832	41.74
6399	Red	4.20		431112.3745	3974329.8041	41.63
6400	Red	7.50		431112.5465	3974329.1018	41.23
6401	Grey	105.50		431111.4626	3974324.4157	37.14
6402	Black	41.40		431110.9806	3974323.3307	36.05
6403	Grey	17.40		431111.0242	3974323.9454	36.50
6404	Black	8.00		431107.2362	3974321.7114	32.22
6405	Black	8.30		431107.4138	3974321.4205	32.15
6406	Black	49.50		431110.0723	3974323.1473	35.26
6407	Black	24.40		431109.9515	3974321.5507	34.10
6408	Black	5.00		431110.8470	3974321.1576	34.52
6409	Black	19.70		431111.7882	3974323.6942	36.90
6410	Red	11.80		431112.6283	3974324.8409	38.29
6411	Grey	45.80		431112.2676	3974324.5571	37.83
6412	Grey	8.40		431113.2010	3974328.9272	41.55
6413	Black	200.50		431116.3116	3974326.8299	42.36
6414	Black	11.90		431115.5870	3974325.7755	41.12
6415	Black	27.80		431114.8178	3974322.3013	38.34
6416	Grey	6.60		431114.5491	3974321.4659	37.62
6417	Red	19.20		431116.4276	3974325.4177	41.54
6418	Grey	4.90		431111.7509	3974318.0359	33.34
6419	Black	12.10		431112.3076	3974317.3965	33.44
6420	Black	38.10		431113.2381	3974318.9987	35.11
6421	Grey	7.90		431117.4645	3974325.1369	42.17
6422	Red	6.00		431119.5821	3974323.8076	43.07
6423	Black	8.60		431120.2839	3974322.1070	42.70
6424	Red	5.10		431120.3345	3974323.7282	43.64
6425	Black	14.60		431119.1405	3974319.9635	40.59
6426	Red	13.90		431118.2981	3974316.4491	38.15
6427	Other	0.00	coverplate	431124.2238	3974320.0974	45.09
6428	Red	17.50		431123.9828	3974322.0843	45.84
6429	Red	5.20		431118.2356	3974315.4847	37.66
6430	Red	6.70		431121.6501	3974317.0378	41.41
6431	Black	13.20		431127.4508	3974313.4239	45.42

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
6432	Black	12.50		431129.3477	3974311.9663	46.80
6433	Black	5.40		431123.2257	3974311.1621	40.71
6434	Black	10.40		431125.8558	3974311.1447	43.22
6435	Red	5.10		431122.2356	3974310.9793	39.71
6436	Black	160.40		431128.4349	3974304.1097	44.35
6437	Black	7.40		431127.5919	3974298.3744	43.22
6438	Black	9.70		431124.1438	3974296.0233	39.87
6439	Red	4.00		431127.6721	3974291.1489	44.00
6440	Yellow	4.80		431122.4449	3974287.7828	39.68
6441	Yellow	39.90		431126.5414	3974287.0517	43.82
6442	Grey	37.70		431125.9838	3974286.1403	43.54
6443	Yellow	27.70		431128.2403	3974283.2421	46.60
6444	Yellow	108.90		431118.7842	3974283.1134	37.89
6445	Grey	29.90		431122.2683	3974279.9892	42.39
6446	Grey	8.20		431124.9013	3974286.7306	42.34
6447	Grey	9.70		431125.0001	3974284.7684	43.04
6448	Yellow	4.40		431125.2595	3974283.0154	43.89
6449	Yellow	31.50		431128.4894	3974276.8894	49.34
6450	Yellow	13.80		431129.9856	3974279.2416	49.70
6451	Yellow	4.50		431127.7794	3974280.9805	46.99
6452	Yellow	10.10		431129.7430	3974282.1684	48.38
6453	Yellow	6.60		431129.5722	3974282.3144	48.17
6454	Yellow	7.00		431132.0675	3974282.7922	50.36
6455	Yellow	10.10		431130.4475	3974281.2068	49.38
6456	Yellow	4.50		431127.1676	3974281.2452	46.32
6457	Yellow	15.10		431127.2027	3974280.0311	46.83
6458	Yellow	7.50		431126.6433	3974279.4606	46.56
6459	Yellow	8.30		431127.4350	3974276.4937	48.58
6460	Yellow	12.30		431126.9548	3974276.5169	48.14
6461	Yellow	4.50		431127.1986	3974276.2174	48.50
6462	Yellow	9.80		431123.7279	3974276.7325	45.21
6463	Yellow	14.50		431119.1541	3974276.3565	41.49
6464	Yellow	10.60		431119.7549	3974275.4168	42.51
6465	Yellow	15.70		431122.9953	3974275.6561	45.12
6466	Yellow	20.30		431124.9558	3974276.4570	46.41
6467	Yellow	5.10		431125.3084	3974269.2734	50.58
6468	Yellow	5.50		431127.2496	3974272.9822	50.14
6469	Yellow	327.70		431117.6582	3974271.7814	42.99
6470	Yellow	20.30		431119.0531	3974270.9396	44.60

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
6471	Yellow	89.00		431121.2118	3974269.3214	47.30
6472	Black	13.40		431098.3740	3974308.2904	16.80
6473	Black	11.70		431099.3080	3974308.3862	17.64
6474	Black	12.30		431102.6283	3974310.3258	21.48
6475	Black	14.00		431102.8739	3974312.2848	22.77
6476	Grey	8.30		431102.6185	3974312.1669	22.50
6477	Black	11.20		431103.8730	3974311.6648	23.25
6478	Black	7.10		431103.5415	3974310.6484	22.43
6479	Black	4.20		431103.7180	3974310.0476	22.27
6480	Black	27.60		431099.3295	3974313.7721	21.02
6481	Black	10.30		431097.6064	3974313.9081	19.93
6482	Black	10.90		431097.0730	3974314.4807	20.02
6483	Black	10.90		431097.5146	3974312.4579	18.81
6484	Black	12.40		431097.8786	3974310.0618	17.46
6485	Grey	83.80		431098.2081	3974309.9763	17.66
6486	Black	6.80		431099.7383	3974310.3003	19.07
6487	Black	6.00		431095.7167	3974314.0043	18.81
6488	Black	6.90		431095.1476	3974313.9472	18.43
6489	Black	8.00		431094.4642	3974313.5862	17.74
6490	Black	12.00		431094.1325	3974313.6265	17.58
6491	Black	21.50		431094.0697	3974314.1997	18.03
6492	Black	67.80		431096.3245	3974316.9268	21.55
6493	Black	23.80		431097.2946	3974317.6592	22.70
6494	Black	28.50		431097.9801	3974316.5196	22.18
6495	Black	12.50		431094.7469	3974316.2992	20.17
6496	Black	25.60		431094.2562	3974316.7512	20.32
6497	Black	8.80		431093.8600	3974315.7412	19.24
6498	Black	154.60		431093.5554	3974315.4210	18.82
6499	Black	146.50		431093.3285	3974314.5492	17.94
6500	Black	10.10		431093.5377	3974315.2261	18.64
6501	Black	12.40		431092.6744	3974312.9101	16.20
6502	Black	7.00		431092.8729	3974311.9703	15.51
6503	Black	7.60		431092.3049	3974311.4527	14.76
6504	Black	11.60		431092.0756	3974311.4723	14.66
6505	Black	27.50		431091.2624	3974313.7446	16.28
6506	Black	17.20		431091.0892	3974312.6030	15.17
6507	Black	23.80		431090.3287	3974312.0077	14.31
6508	Black	10.20		431090.9455	3974311.5746	14.19
6509	Black	34.90		431091.2742	3974311.0680	13.90

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
6510	Black	11.00		431092.3039	3974310.3928	13.88
6511	Black	7.70		431092.1721	3974311.5209	14.75
6512	Black	6.70		431092.7643	3974310.7623	14.45
6513	Black	9.10		431092.9720	3974310.8045	14.60
6514	Black	10.00		431093.1826	3974310.8469	14.76
6515	Black	7.40		431093.2893	3974308.8302	13.27
6516	Black	6.20		431093.6908	3974309.6922	14.18
6517	Black	5.90		431092.6758	3974309.4252	13.33
6518	Grey	15.80		431092.6964	3974309.6942	13.55
6519	Grey	9.20		431092.6475	3974309.8899	13.68
6520	Black	10.10		431091.9575	3974309.7118	13.13
6521	Black	11.10		431090.7965	3974310.9679	13.58
6522	Black	9.00		431090.7878	3974311.4811	14.03
6523	Black	5.70		431090.5369	3974311.9269	14.32
6524	Black	7.50		431089.4927	3974311.9279	13.91
6525	Black	17.30		431090.2066	3974313.1346	15.29
6526	Black	5.50		431089.7936	3974311.9595	14.05
6527	Black	12.00		431091.6348	3974313.4050	16.13
6528	Black	10.60		431092.2366	3974313.2873	16.31
6529	Black	13.20		431094.1407	3974313.6712	17.63
6530	Black	15.20		431094.9608	3974313.1909	17.71
6531	Black	8.20		431091.6549	3974314.0436	16.72
6532	Black	7.50		431092.4833	3974314.1881	17.22
6533	Black	5.80		431091.5563	3974314.3456	16.95
6534	Black	8.50		431092.0238	3974314.3639	17.17
6535	Black	6.10		431091.4808	3974313.4163	16.07
6536	Black	6.30		431092.2439	3974315.0481	17.88
6537	Black	5.50		431092.2845	3974315.8056	18.58
6538	Black	6.30		431092.1582	3974315.7849	18.50
6539	Black	4.90		431091.1770	3974316.7972	19.06
6540	Black	11.60		431090.0717	3974314.5490	16.56
6541	Black	4.20		431089.7380	3974313.4188	15.39
6542	Black	4.60		431089.3279	3974314.5086	16.28
6543	Black	6.20		431090.3096	3974316.1435	18.15
6544	Black	6.50		431088.5377	3974317.1998	18.67
6545	Black	4.80		431089.1393	3974317.7887	19.39
6546	Black	6.20		431089.9928	3974317.1424	19.00
6547	Black	6.10		431088.5979	3974315.5814	17.11
6548	Black	6.70		431088.1110	3974314.2444	15.70

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
6549	Black	10.50		431088.0166	3974325.2462	26.50
6550	Black	7.20		431089.2310	3974327.9271	29.34
6551	Grey	7.20		431081.1652	3974324.2787	25.49
6552	Black	4.70		431081.1253	3974324.6961	25.91
6553	Black	6.20		431077.2777	3974323.6433	25.65
6554	Black	7.20		431084.6392	3974326.1462	27.15
6555	Black	15.50		431087.0786	3974328.4533	29.58
6556	Black	6.90		431086.7728	3974310.7354	11.98
6557	Black	7.50		431086.6931	3974310.5519	11.79
6558	Grey	23.70		431239.0733	3974314.1275	155.43
6559	Green	49.00		431004.3204	3974350.5172	95.21
6560	Green	85.00		430996.0683	3974344.5497	99.37
6561	Black	54.90		430980.2603	3974340.6583	112.15
6562	Green	36.50		430969.7024	3974347.9968	124.71
6563	Green	434.60		430965.6223	3974373.3995	140.14
6564	Black	27.00		431080.4397	3974292.5673	7.54
6565	Black	18.00		431080.1405	3974292.7607	7.54
6566	Black	13.30		431079.5715	3974293.3767	7.40
6567	Black	10.00		431079.1731	3974293.7562	7.39
6568	Black	9.30		431078.1765	3974293.8909	8.03
6569	Black	6.70		431077.9125	3974293.8627	8.26
6570	Black	43.50		431077.2022	3974293.4800	9.05
6571	Black	32.80		431076.8069	3974294.4220	8.85
6572	Black	36.00		431077.7609	3974292.0500	9.59
6573	Black	13.00		431077.7187	3974291.5589	9.98
6574	Black	37.70		431076.0648	3974292.6618	10.45
6575	Black	7.80		431076.1225	3974294.7464	9.29
6576	Black	20.90		431077.0913	3974294.4814	8.57
6577	Black	10.90		431077.8998	3974294.2424	8.04
6578	Red	8.80		431078.5972	3974294.1244	7.56
6579	Black	9.70		431077.2280	3974295.6326	7.90
6580	Black	24.50		431077.3651	3974297.8553	7.11
6581	Black	13.00		431077.4673	3974298.0125	6.98
6582	Black	16.00		431077.0228	3974295.1429	8.31
6583	Grey	9.00		431076.8968	3974295.1909	8.40
6584	Black	8.00		431077.8923	3974298.4009	6.52
6585	Black	14.00		431078.0120	3974298.8665	6.37
6586	Black	6.80		431077.6829	3974298.7356	6.70
6587	Green	13.00		431078.1632	3974298.9902	6.22

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
6588	Black	6.00		431078.1835	3974299.3601	6.21
6589	Black	77.60		431077.5392	3974299.1571	6.84
6590	Black	6.10		431075.6044	3974291.9984	11.22
6591	Black	28.00		431076.5869	3974289.7895	12.06
6592	Black	42.10		431076.1881	3974289.4443	12.58
6593	Black	40.00		431078.1706	3974289.6584	11.21
6594	Black	5.00		431077.7410	3974289.7050	11.42
6595	Black	15.00		431078.5822	3974289.6442	11.00
6596	Black	17.70		431079.1188	3974290.5517	9.95
6597	Black	13.00		431078.4471	3974290.5131	10.35
6598	Black	11.00		431078.6292	3974291.4080	9.52
6599	Black	4.70		431079.7953	3974292.5151	7.94
6600	Black	6.00		431080.0721	3974293.0107	7.37
6601	Black	11.00		431080.6768	3974292.4954	7.48
6602	Black	7.00		431080.7114	3974292.1463	7.77
6603	Black	10.00		431080.7361	3974292.0732	7.82
6604	Black	5.50		431081.3488	3974292.4713	7.19
6605	Black	12.40		431081.4932	3974292.1234	7.45
6606	Black	4.80		431081.6699	3974292.0583	7.45
6607	Black	21.70		431080.2822	3974290.1428	9.75
6608	Black	24.00		431080.9236	3974290.0161	9.62
6609	Black	22.00		431079.5986	3974288.5097	11.52
6610	Black	30.00		431078.5604	3974287.5891	12.80
6611	Black	28.00		431081.1198	3974286.4450	12.97
6612	Black	22.00		431081.3678	3974286.3379	13.01
6613	Black	31.00		431081.7981	3974285.7815	13.46
6614	Black	10.00		431082.1038	3974289.8653	9.41
6615	Black	7.00		431082.2027	3974286.7271	12.46
6616	Black	15.90		431082.2760	3974286.4162	12.75
6617	Black	11.30		431082.7430	3974285.9168	13.18
6618	Black	5.00		431082.5301	3974285.5766	13.54
6619	Black	13.60		431082.9405	3974290.3719	8.74
6620	Black	18.10		431083.0142	3974290.3317	8.77
6621	Black	8.00		431083.4879	3974290.7773	8.27
6622	Black	9.40		431083.8196	3974290.6622	8.35
6623	Black	11.00		431083.6210	3974290.8179	8.21
6624	Black	9.90		431083.4741	3974291.0230	8.02
6625	Black	16.00		431083.6457	3974291.1428	7.89
6626	Black	16.70		431083.6914	3974290.3973	8.62

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
6627	Black	15.00		431084.4512	3974290.8092	8.19
6628	Black	17.80		431084.6539	3974291.3431	7.66
6629	Black	11.00		431085.0894	3974288.7912	10.23
6630	Black	14.00		431084.5099	3974288.3895	10.61
6631	Black	15.40		431085.2283	3974288.5602	10.47
6632	Black	13.80		431085.3952	3974288.5738	10.47
6633	Black	11.00		431085.7418	3974288.3766	10.70
6634	Black	3.00		431085.1325	3974287.7970	11.22
6635	Black	4.90		431085.4668	3974287.0336	12.01
6636	Black	7.50		431085.5613	3974287.3337	11.72
6637	Black	8.60		431085.6307	3974287.3418	11.72
6638	Black	12.00		431085.9572	3974286.6992	12.40
6639	Black	11.00		431084.9400	3974285.4142	13.59
6640	Black	24.00		431085.4484	3974284.6308	14.40
6641	Black	22.50		431085.8002	3974285.5632	13.51
6642	Black	7.30		431085.6231	3974285.5948	13.46
6643	Black	8.00		431084.9004	3974290.0220	8.99
6644	Black	8.00		431085.0721	3974290.3291	8.69
6645	Black	8.30		431084.2086	3974287.7083	11.29
6646	Black	8.00		431087.0738	3974284.6494	14.60
6647	Black	9.00		431087.2164	3974284.5184	14.75
6648	Black	24.70		431086.8865	3974288.4397	10.85
6649	Black	12.40		431086.8047	3974287.7785	11.47
6650	Black	17.70		431087.3599	3974287.0330	12.33
6651	Black	20.50		431087.4092	3974287.1003	12.27
6652	Black	8.00		431087.7035	3974288.3117	11.19
6653	Black	6.00		431087.4059	3974288.1962	11.21
6654	Black	10.00		431086.7037	3974288.9760	10.28
6655	Black	8.90		431086.8833	3974289.0181	10.29
6656	Black	4.40		431085.6473	3974289.2095	9.87
6657	Black	16.00		431085.9912	3974290.3816	8.76
6658	Black	6.40		431085.7778	3974291.1337	7.98
6659	Black	12.00		431085.7711	3974291.3497	7.77
6660	Black	20.00		431085.9073	3974291.5159	7.63
6661	Black	25.00		431087.4694	3974289.6794	9.81
6662	Black	13.60		431087.2709	3974289.8174	9.62
6663	Black	17.50		431087.1037	3974289.7291	9.66
6664	Black	11.00		431087.0665	3974289.8551	9.53
6665	Black	19.30		431086.9912	3974290.1605	9.21

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
6666	Black	16.40		431086.2352	3974290.8233	8.38
6667	Black	6.60		431086.5534	3974290.6160	8.66
6668	Black	5.60		431086.6042	3974290.6256	8.66
6669	Black	5.80		431086.5162	3974290.7127	8.55
6670	Black	6.00		431086.7769	3974290.5636	8.76
6671	Black	8.00		431086.7116	3974290.5404	8.77
6672	Black	5.50		431086.7615	3974290.6624	8.67
6673	Black	9.00		431086.7275	3974290.7892	8.53
6674	Black	5.50		431086.3228	3974290.8008	8.42
6675	Black	8.00		431086.4189	3974291.1778	8.08
6676	Black	6.40		431086.3342	3974291.1636	8.07
6677	Black	8.00		431086.5703	3974291.2830	8.02
6678	Black	12.70		431087.0352	3974291.4183	8.03
6679	Black	20.60		431087.2726	3974291.6067	7.93
6680	Black	5.00		431087.3048	3974291.8899	7.68
6681	Black	6.00		431086.7028	3974291.8500	7.51
6682	Black	5.00		431087.0495	3974292.4153	7.10
6683	Black	11.00		431087.4807	3974291.2232	8.37
6684	Black	5.90		431087.8207	3974290.8702	8.82
6685	Black	28.00		431088.0242	3974290.9075	8.87
6686	Black	28.00		431088.1988	3974290.6066	9.22
6687	Black	4.90		431088.1750	3974290.6704	9.15
6688	Black	8.80		431088.0524	3974289.5486	10.13
6689	Black	7.40		431087.7179	3974287.4640	12.00
6690	Black	14.40		431088.6287	3974287.1433	12.59
6691	Black	15.00		431090.3065	3974284.4248	15.73
6692	Black	15.60		431090.4315	3974284.2285	15.96
6693	Black	16.00		431090.3782	3974284.2286	15.94
6694	Black	12.60		431090.8841	3974283.7855	16.54
6695	Black	36.70		431090.8978	3974284.4940	15.90
6696	Black	37.00		431091.3888	3974284.9627	15.68
6697	Black	8.60		431090.7798	3974284.7818	15.59
6698	Black	11.80		431090.6579	3974285.3934	14.98
6699	Yellow	7.00		431090.5323	3974285.1316	15.17
6700	Black	10.40		431089.9405	3974287.3931	12.86
6701	Black	5.00		431089.7126	3974287.2877	12.86
6702	Black	19.70		431089.4359	3974287.2486	12.79
6703	Black	5.70		431089.2897	3974287.2615	12.72
6704	Black	23.20		431089.1950	3974287.8096	12.18

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
6705	Black	12.00		431089.1733	3974287.9761	12.02
6706	Black	20.40		431088.9738	3974288.5177	11.44
6707	Black	6.00		431088.4753	3974288.9014	10.89
6708	Black	24.20		431089.1560	3974288.6241	11.42
6709	Black	13.60		431089.0637	3974288.9771	11.06
6710	Black	17.80		431089.1980	3974289.0214	11.08
6711	Black	9.50		431089.3110	3974289.1189	11.04
6712	Black	24.20		431089.3365	3974289.0652	11.10
6713	Black	7.00		431089.4823	3974288.8848	11.32
6714	Black	16.50		431089.5628	3974288.6412	11.58
6715	Black	15.80		431089.9425	3974288.1024	12.23
6716	Black	9.30		431089.9677	3974288.1358	12.21
6717	Black	11.40		431090.1205	3974288.3641	12.08
6718	Black	15.50		431089.0953	3974289.3258	10.76
6719	Black	12.00		431089.2319	3974289.8985	10.31
6720	Black	8.70		431088.9297	3974289.9451	10.13
6721	Black	14.00		431088.7128	3974290.1518	9.85
6722	Black	11.00		431088.5978	3974290.2228	9.73
6723	Black	6.80		431087.9749	3974291.6388	8.19
6724	Black	5.00		431087.3984	3974292.1506	7.48
6725	Black	5.00		431087.3853	3974292.4843	7.17
6726	Black	9.00		431087.4054	3974292.5675	7.10
6727	Yellow	15.00		431092.5800	3974285.2180	16.03
6728	Yellow	43.90		431092.5046	3974285.3613	15.87
6729	Black	11.80		431092.3589	3974285.3999	15.76
6730	Black	6.50		431092.3786	3974286.0022	15.26
6731	Black	9.50		431092.2458	3974285.9313	15.25
6732	Red	10.00		431092.0584	3974285.7317	15.32
6733	Black	8.70		431091.4171	3974286.8717	14.02
6734	Black	5.00		431090.7184	3974287.7442	12.91
6735	Black	13.00		431090.7612	3974288.0566	12.66
6736	Black	37.80		431091.2423	3974288.0795	12.89
6737	Black	10.00		431091.4843	3974288.3288	12.81
6738	Black	14.00		431091.1195	3974288.5273	12.45
6739	Black	71.00		431093.1033	3974285.9272	15.71
6740	Yellow	13.40		431092.9377	3974286.0040	15.56
6741	Black	13.80		431093.1650	3974286.1820	15.53
6742	Black	11.00		431093.0562	3974286.5442	15.17
6743	Black	16.90		431093.3670	3974286.4127	15.46

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
6744	Yellow	24.00		431093.3207	3974286.2153	15.60
6745	Yellow	16.80		431092.1754	3974286.7648	14.50
6746	Yellow	10.00		431091.3201	3974287.1919	13.69
6747	Black	10.40		431092.6680	3974286.1646	15.27
6748	Yellow	25.20		431093.5109	3974286.6275	15.37
6749	Black	13.00		431093.5426	3974286.6184	15.40
6750	Black	13.30		431093.3108	3974287.5344	14.53
6751	Black	10.00		431092.5375	3974288.2630	13.48
6752	Black	14.20		431092.3752	3974288.3052	13.35
6753	Black	9.50		431092.0058	3974289.0186	12.56
6754	Black	10.60		431092.1996	3974289.2864	12.46
6755	Black	5.00		431091.6036	3974289.5171	11.92
6756	Black	6.00		431091.5598	3974289.7286	11.72
6757	Black	36.50		431091.1860	3974289.5061	11.68
6758	Black	11.70		431091.0151	3974289.4935	11.59
6759	Black	21.00		431090.8762	3974289.4411	11.55
6760	Black	24.30		431091.1003	3974289.2546	11.83
6761	Black	28.00		431091.0546	3974289.2593	11.80
6762	Black	7.00		431090.8163	3974289.3414	11.60
6763	Black	11.40		431090.1038	3974289.8333	10.80
6764	Black	7.00		431089.9024	3974289.9470	10.60
6765	Black	8.80		431089.6337	3974290.3850	10.09
6766	Black	23.00		431089.8666	3974290.7442	9.91
6767	Black	28.80		431089.9464	3974290.7247	9.97
6768	Black	4.70		431089.0977	3974290.8116	9.44
6769	Black	6.60		431089.0212	3974291.3142	8.97
6770	Black	18.00		431088.9143	3974291.5943	8.68
6771	Black	10.80		431088.7520	3974292.1644	8.11
6772	Black	14.40		431088.4874	3974292.3518	7.81
6773	Black	15.70		431088.4629	3974292.5987	7.59
6774	Black	12.00		431088.6408	3974292.7185	7.58
6775	Black	10.00		431088.5884	3974292.7609	7.52
6776	Black	11.00		431088.5918	3974292.8910	7.41
6777	Black	20.00		431088.4770	3974293.3333	6.99
6778	Black	15.00		431088.9471	3974293.3945	7.23
6779	Yellow	16.00		431088.7842	3974293.5880	6.97
6780	Black	5.00		431090.4666	3974290.5631	10.40
6781	Black	11.30		431090.7713	3974290.7642	10.42
6782	Black	10.00		431091.1817	3974290.8111	10.64

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
6783	Black	7.50		431091.0131	3974290.8579	10.50
6784	Black	8.70		431090.4345	3974291.1250	9.93
6785	Black	8.90		431090.4269	3974291.0467	9.99
6786	Black	39.80		431090.2980	3974291.5620	9.50
6787	Black	6.30		431089.6372	3974290.9290	9.63
6788	Black	6.30		431089.5834	3974291.5781	9.06
6789	Black	12.30		431089.5976	3974291.5960	9.05
6790	Black	9.50		431089.3998	3974291.9504	8.65
6791	Black	8.70		431089.5489	3974291.9727	8.72
6792	Black	6.00		431089.2881	3974292.1050	8.46
6793	Black	7.00		431089.2165	3974292.2605	8.29
6794	Black	4.40		431089.0910	3974292.1602	8.30
6795	Black	8.90		431089.0141	3974292.0857	8.32
6796	Black	15.00		431089.1145	3974292.3691	8.14
6797	Black	7.50		431089.0559	3974292.4655	8.03
6798	Black	21.30		431088.9217	3974292.3417	8.05
6799	Yellow	21.00		431094.7214	3974288.4478	14.77
6800	Black	23.00		431094.6253	3974288.3702	14.76
6801	Yellow	20.00		431093.9922	3974288.6474	14.12
6802	Black	10.00		431094.0315	3974289.7589	13.36
6803	Black	10.00		431093.3757	3974289.9767	12.74
6804	Black	10.00		431092.5824	3974289.8699	12.27
6805	Black	16.70		431092.6078	3974289.8646	12.29
6806	Black	17.00		431091.7640	3974290.2493	11.44
6807	Black	8.10		431091.5739	3974290.6427	11.02
6808	Black	5.70		431091.4244	3974290.5061	11.03
6809	Black	8.90		431090.4330	3974291.8257	9.38
6810	Black	5.80		431090.7002	3974291.9041	9.50
6811	Black	4.40		431090.5262	3974292.0294	9.29
6812	Black	7.20		431090.4084	3974291.9237	9.29
6813	Black	7.70		431090.3281	3974292.0398	9.15
6814	Black	19.20		431089.6958	3974292.0948	8.71
6815	Black	6.60		431089.6438	3974291.9343	8.81
6816	Black	7.80		431089.8252	3974292.9596	8.13
6817	Black	4.30		431089.5570	3974293.1736	7.79
6818	Black	19.50		431089.2361	3974293.9174	7.02
6819	Black	11.60		431088.9368	3974294.0573	6.72
6820	Black	16.00		431088.7709	3974293.9265	6.70
6821	Black	7.30		431088.9750	3974294.0127	6.78

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
6822	Red	26.00		431095.0020	3974288.4605	14.96
6823	Grey	16.50		431095.0794	3974288.4523	15.02
6824	Black	43.50		431094.9054	3974289.7037	14.04
6825	Yellow	23.00		431094.9714	3974289.7418	14.06
6826	Black	19.80		431094.8944	3974289.6663	14.06
6827	Yellow	37.00		431095.5122	3974289.0362	14.94
6828	Yellow	12.60		431095.4775	3974288.9585	14.96
6829	Yellow	22.00		431095.2813	3974288.7890	14.93
6830	Yellow	55.00		431095.0918	3974288.6967	14.86
6831	Yellow	11.20		431094.2183	3974287.9427	14.80
6832	Yellow	6.60		431094.2769	3974288.2561	14.60
6833	Black	7.30		431094.1963	3974289.6750	13.53
6834	Black	4.00		431093.8961	3974290.7470	12.59
6835	Black	8.00		431093.2803	3974290.8320	12.08
6836	Black	5.00		431092.8397	3974290.7671	11.80
6837	Black	6.00		431092.3474	3974291.0586	11.24
6838	Black	5.00		431092.4042	3974291.3600	11.07
6839	Black	8.30		431091.6881	3974291.0258	10.81
6840	Black	18.80		431091.6101	3974291.2672	10.58
6841	Black	9.70		431091.2654	3974291.4403	10.22
6842	Black	16.00		431091.1005	3974291.2818	10.23
6843	Black	6.00		431091.1370	3974291.8682	9.82
6844	Yellow	88.00		431095.4767	3974289.5883	14.55
6845	Yellow	40.70		431095.4750	3974289.2667	14.75
6846	Yellow	64.00		431095.6010	3974289.2672	14.85
6847	Yellow	12.50		431095.5828	3974289.9087	14.42
6848	Yellow	14.50		431095.9181	3974289.8486	14.72
6849	Yellow	68.00		431095.8773	3974289.8438	14.69
6850	Yellow	24.30		431095.4892	3974290.1429	14.20
6851	Black	14.00		431095.6944	3974290.4810	14.16
6852	Yellow	32.00		431094.9879	3974290.3471	13.69
6853	Grey	22.00		431094.6908	3974290.3349	13.46
6854	Black	5.00		431094.6874	3974291.1911	12.93
6855	Black	14.00		431094.6445	3974291.4299	12.75
6856	Black	7.80		431093.7331	3974291.6029	11.92
6857	Black	5.60		431093.1316	3974292.2069	11.07
6858	Black	28.20		431092.5295	3974292.0603	10.70
6859	Black	5.00		431092.2211	3974292.1847	10.38
6860	Black	7.00		431091.8513	3974292.3220	10.02

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
6861	Black	7.00		431091.6044	3974292.1520	9.95
6862	Black	9.70		431091.6613	3974291.9554	10.13
6863	Black	6.40		431091.1119	3974292.8884	9.09
6864	Black	10.70		431090.5965	3974292.6531	8.88
6865	Black	7.00		431090.1426	3974293.1566	8.20
6866	Black	7.30		431089.9948	3974293.1189	8.13
6867	Black	7.00		431089.8182	3974292.9074	8.16
6868	Black	4.40		431089.2438	3974293.5831	7.28
6869	Black	11.00		431089.1696	3974293.8874	7.00
6870	Black	6.80		431096.1614	3974290.0772	14.77
6871	Yellow	42.00		431096.2131	3974290.2736	14.70
6872	Black	9.00		431095.9730	3974290.3820	14.44
6873	Grey	10.70		431095.8784	3974290.3976	14.36
6874	Yellow	13.80		431095.7697	3974290.7742	14.05
6875	Black	16.40		431095.5724	3974291.7636	13.32
6876	Black	8.70		431094.9504	3974292.2722	12.53
6877	Black	18.50		431094.3539	3974291.7184	12.35
6878	Black	10.00		431092.6356	3974292.4217	10.55
6879	Black	19.20		431092.7555	3974293.1316	10.22
6880	Black	8.00		431092.8229	3974293.3633	10.15
6881	Black	7.70		431092.2083	3974292.8617	9.94
6882	Black	5.00		431090.7272	3974293.3048	8.52
6883	Black	5.00		431090.5512	3974293.4322	8.31
6884	Black	6.60		431090.2322	3974293.2276	8.22
6885	Black	10.60		431089.8366	3974293.6574	7.63
6886	Black	20.50		431089.7349	3974293.8562	7.42
6887	Black	12.80		431089.3954	3974294.1922	6.94
6888	Black	22.60		431089.1564	3974294.1084	6.83
6889	Yellow	35.60		431096.5382	3974290.5106	14.82
6890	Black	8.00		431096.9168	3974291.4704	14.62
6891	Black	14.80		431095.8812	3974292.0872	13.42
6892	Grey	43.00		431095.8821	3974292.6463	13.14
6893	Black	12.00		431094.3398	3974293.2584	11.49
6894	Black	25.00		431092.0972	3974294.1860	9.09
6895	Black	16.40		431092.0158	3974293.3540	9.49
6896	Black	5.00		431091.0791	3974293.7446	8.51
6897	Black	12.00		431090.5383	3974294.2977	7.74
6898	Black	7.60		431090.4639	3974294.7012	7.45
6899	Black	32.40		431090.1854	3974294.8925	7.11

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
6900	Black	15.00		431090.4029	3974295.0283	7.21
6901	Black	12.30		431089.6894	3974294.8149	6.76
6902	Black	37.00		431089.6540	3974294.6091	6.86
6903	Black	9.00		431089.9308	3974295.1957	6.73
6904	Yellow	84.00		431097.6865	3974291.3027	15.37
6905	Black	15.00		431097.7075	3974291.4298	15.32
6906	Yellow	22.00		431097.8400	3974291.7347	15.29
6907	Yellow	17.00		431098.2263	3974291.8311	15.59
6908	Black	136.60		431098.8943	3974292.4744	15.91
6909	Grey	7.80		431098.7911	3974292.3432	15.87
6910	Black	8.50		431098.8044	3974292.4261	15.85
6911	Black	6.00		431097.5196	3974293.6480	14.18
6912	Black	20.00		431097.0680	3974292.8021	14.12
6913	Red	14.20		431096.4509	3974292.8515	13.54
6914	Grey	29.00		431096.4317	3974293.0612	13.43
6915	Grey	9.90		431096.4216	3974292.5530	13.66
6916	Grey	12.90		431096.2297	3974292.5668	13.48
6917	Black	9.70		431092.8939	3974295.0409	9.39
6918	Black	17.90		431092.5512	3974294.8721	9.15
6919	Black	11.00		431092.2918	3974294.9154	8.90
6920	Black	9.80		431091.6029	3974294.9534	8.28
6921	Black	6.80		431091.2445	3974295.6058	7.65
6922	Black	11.60		431090.6509	3974295.6663	7.10
6923	Black	8.00		431090.6680	3974295.6901	7.10
6924	Black	5.00		431090.4812	3974295.6486	6.96
6925	Grey	10.00		431099.2243	3974295.2127	15.32
6926	Black	15.30		431097.7136	3974295.1862	13.87
6927	Black	8.80		431096.7304	3974295.6608	12.79
6928	Black	9.30		431096.0781	3974296.0060	12.07
6929	Yellow	41.00		431096.0706	3974295.9981	12.07
6930	Black	11.00		431095.7206	3974294.6200	12.15
6931	Black	5.50		431095.5916	3974294.5739	12.05
6932	Black	7.10		431095.3778	3974294.7924	11.77
6933	Black	7.10		431094.9567	3974295.1783	11.24
6934	Black	10.00		431094.8797	3974295.1329	11.19
6935	Black	7.90		431094.4935	3974295.2573	10.78
6936	Black	14.90		431093.8597	3974295.0081	10.28
6937	Black	6.80		431093.6185	3974295.3398	9.93
6938	Black	7.50		431100.9847	3974295.6965	16.93

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
6939	Black	8.00		431098.2307	3974296.4574	14.08
6940	Black	15.00		431095.7725	3974297.4782	11.49
6941	Black	10.80		431095.8210	3974297.4848	11.54
6942	Black	6.80		431095.2638	3974298.5224	10.89
6943	Black	5.70		431093.3692	3974296.0849	9.45
6944	Black	16.00		431092.5998	3974296.4864	8.59
6945	Black	5.00		431090.7493	3974296.3966	6.88
6946	Black	5.00		431090.5755	3974296.3418	6.74
6947	Black	14.00		431090.6120	3974297.2485	6.47
6948	Black	28.70		431090.2015	3974297.1945	6.09
6949	Black	22.00		431090.3319	3974297.4176	6.16
6950	Black	17.60		431093.9659	3974297.8229	9.66
6951	Black	7.40		431093.9535	3974297.7591	9.65
6952	Black	13.00		431093.2316	3974297.9762	8.91
6953	Black	17.00		431091.2664	3974297.5362	7.04
6954	Black	14.00		431090.8463	3974296.9083	6.79
6955	Black	33.60		431101.3667	3974300.1096	17.02
6956	Black	61.00		431101.5898	3974301.0212	17.33
6957	Black	5.00		431101.8369	3974301.0018	17.57
6958	Black	5.70		431097.2240	3974300.5710	12.94
6959	Black	11.90		431096.6872	3974299.8747	12.34
6960	Grey	28.00		431095.9844	3974299.5993	11.62
6961	Black	18.70		431095.1695	3974299.3177	10.79
6962	Black	5.40		431094.1950	3974299.2443	9.82
6963	Black	12.00		431094.1849	3974298.5778	9.81
6964	Black	8.00		431093.8019	3974299.1592	9.42
6965	Black	6.50		431093.3470	3974298.6949	8.97
6966	Black	8.80		431093.3772	3974297.8937	9.06
6967	Grey	22.70		431090.3515	3974297.5928	6.13
6968	Black	9.30		431090.3231	3974297.7759	6.07
6969	Black	22.00		431090.2336	3974298.2507	5.90
6970	Black	5.90		431090.8259	3974298.0436	6.51
6971	Black	12.00		431099.1388	3974302.9634	15.28
6972	Black	13.00		431097.5006	3974301.7347	13.40
6973	Black	9.40		431097.2246	3974301.0610	13.01
6974	Black	7.50		431096.3330	3974300.5345	12.05
6975	Black	18.30		431096.1372	3974301.3626	11.99
6976	Black	5.00		431095.6152	3974301.8846	11.60
6977	Grey	95.00		431094.6558	3974300.9394	10.46

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
6978	Black	6.60		431094.2732	3974301.1506	10.12
6979	Black	25.00		431093.8468	3974300.3352	9.56
6980	Black	7.00		431092.1940	3974300.6069	7.98
6981	Black	13.20		431090.8267	3974300.4421	6.61
6982	Black	5.00		431090.9088	3974300.7656	6.76
6983	Black	8.90		431090.4795	3974300.8972	6.39
6984	Black	33.00		431089.8428	3974300.3381	5.62
6985	Black	19.90		431089.4002	3974300.7172	5.31
6986	Black	14.40		431094.9089	3974302.2452	11.02
6987	Black	8.50		431093.6610	3974302.3337	9.86
6988	Black	6.80		431092.7834	3974302.1036	8.96
6989	Black	13.00		431095.3200	3974303.8358	11.96
6990	Black	23.00		431094.4491	3974304.3735	11.42
6991	Black	9.00		431093.5702	3974304.0919	10.51
6992	Black	6.20		431092.5383	3974304.0229	9.58
6993	Black	12.00		431092.1358	3974304.4661	9.49
6994	Black	17.00		431091.9148	3974303.9264	9.00
6995	Grey	10.30		431091.8549	3974303.5217	8.74
6996	Black	9.00		431091.7590	3974303.3090	8.55
6997	Black	19.80		431095.4623	3974308.8407	14.82
6998	Black	40.00		431094.9754	3974307.1187	13.35
6999	Black	7.80		431094.1882	3974305.8990	11.99
7000	Black	14.00		431093.8408	3974304.9826	11.20
7001	Black	22.00		431091.2979	3974305.4292	9.45
7002	Black	13.50		431090.3476	3974306.0682	9.25
7003	Black	8.80		431089.9369	3974304.8397	8.06
7004	Black	44.00		431089.7480	3974304.2613	7.52
7005	Black	9.70		431089.3846	3974304.2255	7.24
7006	Black	7.00		431089.4217	3974304.0995	7.17
7007	Black	7.00		431089.0577	3974303.2489	6.32
7008	Black	38.00		431088.7985	3974302.8089	5.84
7009	Black	7.20		431088.5706	3974301.9916	5.15
7010	Black	15.40		431090.0933	3974307.8573	10.54
7011	Black	5.90		431090.1148	3974308.1289	10.79
7012	Black	7.00		431090.1126	3974307.4322	10.20
7013	Black	8.20		431090.5835	3974306.8902	10.04
7014	Black	31.00		431089.7309	3974306.7865	9.45
7015	Black	14.60		431089.3689	3974306.6993	9.18
7016	Black	7.00		431089.3287	3974306.7190	9.17

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
7017	Black	31.00		431088.9567	3974306.3741	8.68
7018	Black	16.70		431088.8478	3974306.5472	8.77
7019	Black	30.00		431088.6834	3974306.6118	8.75
7020	Black	11.00		431088.2995	3974307.0158	8.93
7021	Black	10.00		431089.5109	3974306.3685	8.98
7022	Black	7.40		431089.9172	3974306.1392	9.04
7023	Black	15.00		431088.9588	3974304.6851	7.30
7024	Black	376.00		431088.2019	3974305.6773	7.70
7025	Black	4.00		431088.2445	3974305.6053	7.66
7026	Black	6.00		431088.0684	3974303.9835	6.20
7027	Black	14.00		431087.4498	3974303.7003	5.62
7028	Black	10.00		431087.4431	3974303.5524	5.49
7029	Black	27.40		431086.7686	3974303.1708	4.81
7030	Black	37.80		431088.0602	3974306.0405	7.95
7031	Black	21.00		431087.7712	3974305.7711	7.58
7032	Black	167.00		431087.7613	3974306.4945	8.23
7033	Black	7.00		431087.5829	3974306.1580	7.85
7034	Grey	14.20		431087.4720	3974306.2498	7.89
7035	Black	6.90		431087.3102	3974305.9108	7.51
7036	Black	7.00		431087.3851	3974305.8665	7.50
7037	Black	10.50		431086.6975	3974305.9468	7.33
7038	Black	14.00		431086.3246	3974305.2802	6.58
7039	Black	15.60		431086.3482	3974305.1451	6.46
7040	Black	7.00		431086.4301	3974304.7921	6.15
7041	Black	19.00		431086.1019	3974304.3448	5.62
7042	Black	5.00		431086.3552	3974304.3068	5.67
7043	Black	13.40		431086.6895	3974304.2316	5.72
7044	Black	6.20		431086.2650	3974303.8943	5.25
7045	Black	11.00		431086.3828	3974303.6313	5.05
7046	Black	6.40		431087.9298	3974304.3564	6.43
7047	Black	6.70		431084.6327	3974307.0463	8.06
7048	Black	10.00		431087.7048	3974307.6776	9.30
7049	Black	8.30		431087.4603	3974306.8172	8.41
7050	Black	13.00		431088.4914	3974307.8928	9.80
7051	Black	5.70		431088.5605	3974307.8264	9.77
7052	Black	7.40		431088.6807	3974310.3055	12.10
7053	Black	6.40		431087.4325	3974309.1291	10.58
7054	Black	7.80		431086.8373	3974308.9936	10.30
7055	Black	5.00		431086.2936	3974308.4438	9.64

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
7056	Black	6.40		431087.0015	3974308.2652	9.63
7057	Black	7.00		431087.0134	3974307.9637	9.35
7058	Yellow	41.80		431086.0551	3974308.1877	9.34
7059	Black	13.00		431086.0406	3974307.4972	8.66
7060	Black	9.00		431085.7234	3974307.4068	8.52
7061	Grey	9.00		431085.0447	3974308.8328	9.86
7062	Black	9.00		431083.6888	3974307.6898	8.72
7063	Black	8.60		431083.1308	3974307.2255	8.33
7064	Black	14.00		431083.2230	3974306.6347	7.73
7065	Black	5.00		431082.9302	3974306.3754	7.52
7066	Black	6.40		431083.0943	3974305.1223	6.26
7067	Black	7.00		431080.7388	3974305.8509	7.76
7068	Black	8.20		431080.9298	3974306.4153	8.18
7069	Black	9.00		431081.6427	3974307.7020	9.13
7070	Black	6.00		431079.8090	3974308.8799	10.89
7071	Black	8.00		431079.5061	3974309.1738	11.29
7072	Black	7.40		431078.0622	3974308.1739	11.14
7073	Black	6.30		431078.2902	3974306.9785	10.04
7074	Black	18.20		431078.3087	3974306.0648	9.32
7075	Black	22.70		431078.0711	3974304.9777	8.70
7076	Black	7.70		431078.1687	3974304.4791	8.29
7077	Black	12.00		431077.4412	3974304.1107	8.62
7078	Black	6.00		431077.9843	3974303.4381	7.79
7079	Black	5.50		431077.9839	3974303.5734	7.87
7080	Black	8.80		431079.9678	3974303.4592	6.28
7081	Black	9.90		431081.1340	3974303.3688	5.45
7082	Grey	10.40		431081.7045	3974303.1510	4.94
7083	Black	8.40		431080.0502	3974302.0905	5.32
7084	Black	16.20		431078.8168	3974301.7627	6.21
7085	Black	24.00		431079.3406	3974300.1829	5.18
7086	Black	115.00		431065.9586	3974310.5310	21.74
7087	Black	5.00		431064.9827	3974309.8132	22.21
7088	Black	29.00		431068.3775	3974313.8891	21.86
7089	Green	19.90		431066.9542	3974310.3356	20.79
7090	Green	13.00		431067.1696	3974310.0875	20.48
7091	Black	8.70		431067.7355	3974308.6036	19.22
7092	Black	26.50		431068.4106	3974308.9178	18.80
7093	Black	18.00		431068.3230	3974307.9132	18.37
7094	Black	18.40		431068.9905	3974307.1965	17.44

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
7095	Black	80.00		431064.1261	3974313.0798	24.67
7096	Black	102.70		431065.7104	3974312.6167	23.11
7097	Black	15.90		431069.9056	3974305.0598	15.69
7098	Black	6.90		431070.9654	3974305.1947	14.78
7099	Black	7.30		431071.2758	3974304.9596	14.40
7100	Black	7.50		431073.0468	3974304.6762	12.68
7101	Black	6.70		431072.7512	3974304.0987	12.70
7102	Black	6.30		431073.6856	3974304.9711	12.25
7103	Black	10.50		431074.3469	3974304.7643	11.57
7104	Black	14.00		431075.3896	3974302.1484	9.53
7105	Black	10.00		431075.9410	3974302.3945	9.10
7106	Black	14.40		431076.0816	3974302.2940	8.93
7107	Black	8.00		431076.4427	3974302.5038	8.68
7108	Black	13.00		431076.6443	3974302.3176	8.42
7109	Black	10.30		431076.8482	3974302.5796	8.34
7110	Black	34.90		431077.0034	3974301.0674	7.66
7111	Black	12.00		431077.4499	3974301.3551	7.32
7112	Black	7.90		431077.4968	3974301.3766	7.28
7113	Black	9.00		431077.5628	3974301.4233	7.24
7114	Black	8.50		431077.5641	3974301.7703	7.36
7115	Black	9.60		431061.4835	3974303.4373	23.32
7116	Black	8.90		431069.8303	3974303.5468	15.25
7117	Black	7.20		431070.0884	3974303.4968	14.98
7118	Black	13.40		431070.3387	3974302.5793	14.49
7119	Black	9.30		431070.9589	3974302.2543	13.81
7120	Black	6.30		431073.2576	3974302.9017	11.79
7121	Black	6.40		431073.5935	3974301.2371	11.02
7122	Black	25.70		431077.9434	3974299.0234	6.44
7123	Black	6.40		431078.6391	3974298.9412	5.74
7124	Black	14.00		431078.5146	3974299.5646	5.89
7125	Grey	33.40		431078.3135	3974299.6226	6.10
7126	Black	15.00		431078.9075	3974299.7143	5.52
7127	Green	19.70		431072.2210	3974297.2402	12.29
7128	Red	29.50		431072.3750	3974296.9625	12.18
7129	Green	10.70		431072.8998	3974297.7767	11.55
7130	Red	19.00		431086.3682	3974276.6618	22.42
7131	Black	14.00		431115.6567	3974273.8991	40.10
7132	Black	19.20		431117.1906	3974274.5110	40.94
7133	Black	27.00		431117.8618	3974274.8884	41.26

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
7134	Black	11.00		431117.3136	3974275.6250	40.38
7135	Black	61.60		431113.9141	3974276.6500	37.03
7136	Black	16.60		431109.1124	3974275.3881	34.19
7137	Black	35.40		431112.0814	3974273.8604	37.40
7138	Black	7.20		431104.6249	3974280.6063	27.35
7139	Yellow	313.70		431108.1474	3974276.6691	32.61
7140	Black	33.00		431106.2414	3974278.0774	30.26
7141	Black	48.00		431106.2629	3974278.0477	30.29
7142	Yellow	4.50		431123.4185	3974274.2497	46.22
7143	Yellow	13.40		431120.7218	3974271.3598	45.65
7144	Yellow	4.00		431119.6608	3974270.9965	45.04
7145	Yellow	5.20		431122.0655	3974269.2042	48.04
7146	Yellow	22.30		431123.4376	3974270.9853	48.06
7147	Yellow	15.30		431125.1655	3974268.0372	51.20
7148	Yellow	24.50		431127.3307	3974266.7856	53.69
7149	Yellow	29.30		431123.7786	3974266.2563	51.22
7150	Yellow	6.50		431121.4141	3974267.8652	48.38
7151	Yellow	5.50		431126.9842	3974266.5626	53.54
7152	Yellow	7.00		431127.0532	3974265.9769	53.95
7153	Yellow	4.20		431126.1487	3974264.7423	54.02
7154	Yellow	4.70		431123.2059	3974264.5146	51.93
7155	Yellow	9.40		431117.6762	3974266.5908	46.46
7156	Yellow	13.70		431118.9233	3974266.7291	47.27
7157	Yellow	9.00		431116.6466	3974265.1194	46.78
7158	Yellow	9.00		431120.9813	3974263.5594	50.94
7159	Yellow	10.80		431121.3203	3974263.5949	51.16
7160	Yellow	11.20		431124.3250	3974262.2400	54.28
7161	Yellow	21.80		431118.1386	3974262.4731	49.73
7162	Yellow	7.00		431120.9003	3974258.2441	54.72
7163	Yellow	25.20		431115.7596	3974262.4251	48.19
7164	Yellow	22.00		431119.9799	3974257.3582	54.78
7165	Yellow	11.80		431111.8334	3974258.6308	48.81
7166	Yellow	22.80		431114.8114	3974257.0638	51.81
7167	Yellow	4.60		431116.8688	3974256.5217	53.47
7168	Yellow	16.60		431116.2480	3974258.5468	51.49
7169	Yellow	406.40		431111.8975	3974261.5499	46.47
7170	Yellow	33.00		431117.5334	3974255.4757	54.71
7171	Yellow	5.20		431112.5063	3974256.0030	51.37
7172	Yellow	14.50		431112.9242	3974254.3622	52.98

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
7173	Yellow	54.00		431109.7125	3974258.4750	47.79
7174	Yellow	15.30		431108.6895	3974256.9876	48.53
7175	Yellow	4.90		431109.8431	3974255.4452	50.45
7176	Grey	7.80		431105.6519	3974255.8627	48.09
7177	Red	16.40		431102.3614	3974259.2760	43.60
7178	Yellow	13.30		431102.0771	3974259.7021	43.09
7179	Yellow	16.30		431099.7123	3974259.9400	41.96
7180	Red	3.10		431100.4983	3974256.6241	45.33
7181	Yellow	6.40		431098.2553	3974254.6729	46.44
7182	Red	6.00		431096.6561	3974256.1430	44.57
7183	Grey	7.20		431093.1376	3974254.7968	45.06
7184	Red	32.30		431088.3978	3974260.8065	38.40
7185	Yellow	99.90		431087.4246	3974259.7425	39.37
7186	Grey	56.40		431074.4386	3974255.3954	44.72
7187	Red	5.80		431076.3243	3974253.4859	46.22
7188	Red	11.20		431074.2157	3974267.1397	33.44
7189	Red	18.90		431068.9861	3974260.5355	41.43
7190	Red	6.20		431068.5457	3974260.5172	41.61
7191	Yellow	4.10		431070.3932	3974266.4962	35.38
7192	Red	9.20		431068.4179	3974270.2920	32.84
7193	Red	5.60		431068.5900	3974269.6242	33.35
7194	Red	8.90		431066.4989	3974265.5626	37.91
7195	Red	4.50		431066.3625	3974265.2181	38.28
7196	Red	69.90		431062.5429	3974262.8261	42.25
7197	Grey	10.10		431061.8366	3974263.8115	41.79
7198	Red	7.00		431064.5658	3974258.6773	44.92
7199	Grey	6.30		431063.8889	3974266.1315	38.73
7200	Grey	5.90		431064.3912	3974265.7940	38.75
7201	Red	5.90		431063.5664	3974265.9126	39.09
7202	Red	9.30		431062.4730	3974265.6690	39.88
7203	Red	21.30		431060.9203	3974259.7494	45.72
7204	Red	5.10		431059.0675	3974260.9386	45.71
7205	Red	7.20		431061.8283	3974261.9252	43.39
7206	Red	6.30		431060.2718	3974261.5842	44.51
7207	Black	8.40		431059.2917	3974263.2964	43.63
7208	Red	78.30		431059.2055	3974264.3030	42.86
7209	Red	6.30		431060.2623	3974264.8176	41.83
7210	Grey	5.70		431060.3609	3974267.5955	39.53
7211	Red	7.10		431062.1110	3974270.4541	36.20

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
7212	Grey	19.70		431062.9960	3974269.8339	36.16
7213	Red	4.70		431059.2029	3974270.3154	38.16
7214	Black	659.70		431056.7458	3974271.4383	39.03
7215	Grey	9.60		431057.5787	3974271.5135	38.39
7216	Black	8.70		431057.5418	3974271.5258	38.40
7217	Black	6.90		431057.0382	3974271.4019	38.85
7218	Black	8.10		431057.5761	3974270.8290	38.88
7219	Red	17.60		431058.1310	3974268.2465	40.43
7220	Grey	4.70		431059.5988	3974266.0728	41.21
7221	Red	12.60		431059.2324	3974265.9316	41.54
7222	Red	8.50		431057.3923	3974273.3525	37.23
7223	Red	11.30		431055.5563	3974270.3549	40.63
7224	Red	4.80		431054.8305	3974269.7001	41.61
7225	Red	4.50		431054.2960	3974269.8214	41.91
7226	Red	4.20		431054.8841	3974269.2801	41.87
7227	Red	39.40		431056.5898	3974265.2941	43.68
7228	Red	7.30		431056.2977	3974265.0258	44.07
7229	Red	5.70		431053.7313	3974263.6330	46.80
7230	Red	47.90		431052.5519	3974265.4446	46.25
7231	Black	8.60		431052.6302	3974264.8943	46.59
7232	Red	5.30		431052.9034	3974262.1895	48.43
7233	Red	14.70		431054.0040	3974261.3293	48.39
7234	Red	9.90		431054.5559	3974261.2793	48.08
7235	Red	8.10		431054.0579	3974262.3830	47.54
7236	Red	6.70		431050.9694	3974261.2818	50.38
7237	Red	14.20		431050.9502	3974261.7979	50.01
7238	Red	9.10		431049.4201	3974263.5819	49.76
7239	Red	6.60		431050.8360	3974266.0573	47.01
7240	Other	70.20	rebar	431051.3651	3974269.8226	44.06
7241	Red	5.50		431051.3307	3974268.6591	44.86
7242	Black	4.00		431050.1240	3974268.1046	46.13
7243	Red	6.30		431049.8802	3974264.9286	48.48
7244	Red	7.30		431048.9615	3974262.8166	50.63
7245	Red	11.90		431046.8769	3974263.5113	51.63
7246	Red	12.90		431050.9423	3974272.3662	42.75
7247	Red	12.70		431050.9647	3974272.0833	42.91
7248	Red	14.30		431050.5487	3974272.2975	43.10
7249	Red	4.20		431050.6234	3974272.6828	42.80
7250	Red	7.70		431047.9541	3974271.5733	45.59

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
7251	Red	6.40		431048.3739	3974272.0649	44.96
7252	Black	6.50		431050.0728	3974273.7385	42.60
7253	Red	5.60		431048.1184	3974272.5867	44.86
7254	Red	7.90		431049.4604	3974274.7096	42.53
7255	Red	5.40		431045.4195	3974270.5240	48.26
7256	Red	11.40		431044.6135	3974267.8453	50.51
7257	Red	4.80		431044.5786	3974264.0958	52.94
7258	Red	6.00		431043.6113	3974268.5424	50.89
7259	Red	5.50		431051.2199	3974271.9152	42.81
7260	Red	62.00		431053.7391	3974270.3818	41.92
7261	Black	8.50		431049.6291	3974275.1584	42.14
7262	Black	6.30		431051.1423	3974274.5931	41.23
7263	Red	5.20		431042.5607	3974274.3006	48.57
7264	Black	4.30		431046.6612	3974277.9411	43.20
7265	Red	4.80		431046.5055	3974283.1345	41.06
7266	Black	6.70		431048.4173	3974283.1823	39.29
7267	Black	10.50		431043.4063	3974287.8757	42.46
7268	Black	6.60		431046.0685	3974286.8251	40.20
7269	Red	9.00		431048.6369	3974285.6686	38.15
7270	Black	4.70		431043.4141	3974289.3909	42.08
7271	Other	57.40	rebar	431047.8694	3974290.6702	37.45
7272	Black	4.00		431044.9237	3974298.0066	39.47
7273	Green	6.50		431052.9351	3974301.3397	31.53
7274	Black	4.40		431048.8146	3974306.8310	36.42
7275	Green	7.60		431051.2233	3974313.4621	36.18
7276	Green	4.60		431051.9985	3974311.9836	34.89
7277	Green	39.90		431047.1174	3974313.3128	39.92
7278	Green	5.40		431047.0972	3974312.7795	39.75
7279	Green	61.40		431055.5251	3974313.6566	32.37
7280	Black	91.80		431059.0349	3974316.8425	31.00
7281	Green	4.10		431056.8413	3974318.0412	33.48
7282	Green	18.90		431056.9453	3974318.6352	33.74
7283	Green	5.40		431043.4086	3974316.7408	44.65
7284	Black	4.70		431048.7859	3974318.3729	40.53
7285	Green	5.30		431051.3495	3974318.9889	38.61
7286	Green	6.40		431050.5378	3974319.0654	39.35
7287	Black	4.30		431051.2058	3974319.7318	39.12
7288	Green	12.80		431044.5995	3974323.2161	46.58
7289	Green	4.80		431053.6794	3974325.6523	40.66

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
7290	Black	6.00		431055.3133	3974327.4679	40.69
7291	Black	6.20		431063.5142	3974324.5370	32.98
7292	Black	50.00		431065.2577	3974328.5126	35.17
7293	Black	13.50		431062.8144	3974329.7043	37.53
7294	Red	28.00		431058.6457	3974326.3572	37.56
7295	Green	5.10		431057.7296	3974329.3303	40.38
7296	Green	14.00		431057.2897	3974328.9671	40.40
7297	Black	8.00		431065.5650	3974323.3843	30.80
7298	Black	5.40		431067.3977	3974323.4416	29.77
7299	Yellow	8.30		431067.4164	3974323.3384	29.67
7300	Green	8.80		431056.2424	3974327.2375	39.87
7301	Black	13.40		431068.5018	3974329.4315	34.33
7302	Black	8.10		431067.9024	3974328.8174	34.07
7303	Black	6.50		431067.9519	3974330.1985	35.26
7304	Black	7.00		431068.5902	3974328.0640	33.08
7305	Black	8.00		431068.8089	3974324.0779	29.52
7306	Black	7.50		431064.8214	3974332.3637	38.68
7307	Black	4.40		431072.4066	3974333.3838	36.41
7308	Black	10.80		431075.6075	3974330.6570	32.86
7309	Black	5.40		431072.0211	3974326.4812	30.14
7310	Black	9.30		431075.4366	3974329.5242	31.81
7311	Black	5.80		431077.2109	3974327.2378	29.14
7312	Yellow	13.00		431069.7454	3974333.6978	37.66
7313	Black	6.90		431081.8505	3974330.2697	31.38
7314	Black	6.40		431082.0178	3974328.7752	29.87
7315	Black	9.70		431074.8710	3974322.8214	25.65
7316	Black	4.80		431082.0260	3974327.4797	28.58
7317	Yellow	30.60		431081.4918	3974327.5445	28.70
7318	Black	21.90		431079.2607	3974326.4013	27.88
7319	Black	5.80		431079.9788	3974326.4789	27.83
7320	Black	36.10		431083.7943	3974332.5030	33.51
7321	Black	8.50		431084.6394	3974332.9101	33.92
7322	Yellow	14.80		431085.8082	3974334.8849	35.92
7323	Black	7.10		431086.2604	3974334.4035	35.46
7324	Black	6.90		431087.7571	3974335.7447	36.91
7325	Black	6.40		431087.5847	3974334.5830	35.73
7326	Grey	4.70		431086.1621	3974333.1453	34.20
7327	Black	10.80		431089.9965	3974331.6117	33.10
7328	Black	4.40		431078.8973	3974329.9801	31.47

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
7329	Black	7.20		431086.2102	3974329.0013	30.06
7330	Grey	6.20		431086.7796	3974328.3739	29.48
7331	Black	12.50		431090.4200	3974331.8817	33.44
7332	Black	6.60		431089.4133	3974330.7669	32.17
7333	Black	7.00		431090.2878	3974330.4545	32.01
7334	Black	9.60		431093.5312	3974328.4297	30.82
7335	Black	5.10		431092.8174	3974327.0975	29.34
7336	Black	6.20		431088.9237	3974326.5552	27.93
7337	Black	5.00		431088.9850	3974324.7048	26.12
7338	Black	10.50		431084.7298	3974322.1609	23.17
7339	Grey	6.70		431088.4828	3974322.1015	23.47
7340	Grey	7.90		431093.9181	3974324.2881	27.03
7341	Black	5.30		431089.5918	3974321.0030	22.62
7342	Black	10.90		431095.1966	3974323.7911	27.05
7343	Black	5.90		431093.0640	3974318.7314	21.56
7344	Black	5.10		431091.7695	3974318.9416	21.27
7345	Black	4.90		431091.3358	3974317.7214	19.98
7346	Black	5.70		431091.3241	3974320.6038	22.70
7347	Grey	4.70		431091.7209	3974320.3797	22.61
7348	Black	7.40		431093.5454	3974319.2056	22.19
7349	Black	8.30		431092.9864	3974319.6915	22.41
7350	Black	6.10		431092.4332	3974320.2714	22.75
7351	Black	5.10		431093.4639	3974322.6932	25.38
7352	Black	5.30		431093.2443	3974322.6724	25.28
7353	Black	6.10		431093.1073	3974322.4712	25.05
7354	Black	13.00		431095.0087	3974320.7439	24.21
7355	Black	4.90		431094.4147	3974319.6831	22.99
7356	Black	5.30		431094.4852	3974319.2347	22.62
7357	Black	6.60		431096.3742	3974322.2874	26.20
7358	Black	5.70		431096.4945	3974321.0807	25.19
7359	Black	5.60		431093.8804	3974321.6695	24.58
7360	Grey	8.60		431096.2763	3974319.1812	23.43
7361	Black	4.50		431089.6779	3974324.0331	25.59
7362	Black	5.00		431089.6518	3974323.2948	24.87
7363	Black	5.50		431087.6685	3974319.0503	20.32
7364	Black	5.00		431094.1044	3974321.1320	24.18
7365	Black	5.20		431088.8047	3974320.1758	21.64
7366	Grey	6.90		431092.7914	3974320.8030	23.37
7367	Black	5.90		431093.8086	3974317.1149	20.43

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
7368	Black	5.40		431093.9375	3974318.4469	21.67
7369	Red	5.80		431095.8037	3974317.3750	21.64
7370	Black	4.50		431094.2862	3974315.9166	19.61
7371	Black	6.70		431095.2143	3974319.0218	22.77
7372	Green	6.70		431096.2496	3974319.9586	24.09
7373	Black	4.80		431098.8134	3974323.2909	28.26
7374	Grey	5.30		431099.2232	3974321.0112	26.55
7375	Black	8.80		431096.9154	3974319.3143	23.88
7376	Black	9.70		431101.6146	3974320.6634	27.69
7377	Grey	6.20		431102.7748	3974320.5420	28.33
7378	Red	17.90		431100.1521	3974316.8425	23.82
7379	Red	14.20		431100.4096	3974316.6638	23.86
7380	Grey	5.00		431098.5185	3974315.2861	21.57
7381	Black	6.80		431100.2615	3974318.1997	24.92
7382	Black	5.00		431100.6840	3974318.7622	25.62
7383	Red	5.90		431099.5806	3974313.4085	20.95
7384	Black	5.90		431095.8472	3974313.9402	18.84
7385	Black	5.10		431104.5781	3974311.8092	23.92
7386	Black	5.80		431105.7006	3974310.2943	24.13
7387	Black	5.60		431114.4172	3974314.9630	34.02
7388	Grey	6.30		431114.1506	3974309.0588	31.42
7389	Grey	4.90		431107.5328	3974304.5863	23.82
7390	Black	10.80		431107.9066	3974303.6872	23.99
7391	Red	5.70		431109.1730	3974302.2070	25.00
7392	Other	29.90	paint chip	431108.5143	3974300.9981	24.22
7393	Black	6.70		431110.5441	3974301.7699	26.31
7394	Black	5.00		431112.2119	3974301.6771	27.96
7395	Green	4.70		431108.2049	3974296.4136	23.96
7396	Black	11.70		431114.9765	3974302.0199	30.74
7397	Black	143.20		431115.8907	3974292.8734	32.10
7398	Yellow	74.00		431117.6424	3974289.1848	34.68
7399	Black	20.40		431119.3185	3974288.2874	36.54
7400	Yellow	14.50		431111.0055	3974289.8708	28.14
7401	Yellow	13.40		431115.7925	3974279.7992	36.81
7402	Yellow	157.10		431114.4699	3974275.5227	38.16
7403	Yellow	54.10		431113.9061	3974276.1930	37.30
7404	Yellow	7.20		431106.7618	3974284.0716	26.90
7405	Yellow	51.70		431106.1288	3974285.3605	25.67
7406	Yellow	6.80		431106.2398	3974285.7397	25.56

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
7407	Yellow	25.90		431108.1113	3974287.7375	26.26
7408	Yellow	36.40		431115.2078	3974287.1158	33.04
7409	Yellow	24.90		431113.2338	3974287.7389	30.97
7410	Yellow	24.60		431111.6012	3974285.0046	30.60
7411	Yellow	19.10		431108.1944	3974281.4488	29.58
7412	Yellow	6.20		431110.0507	3974280.4975	31.64
7413	Yellow	43.40		431109.6824	3974277.6764	33.09
7414	Yellow	7.10		431111.4710	3974276.8520	34.99
7415	Yellow	41.60		431111.0809	3974274.4147	36.29
7416	Yellow	39.40		431115.0337	3974280.4800	35.81
7417	Yellow	8.50		431117.4168	3974279.3303	38.45
7418	Yellow	205.10		431117.7539	3974279.2279	38.79
7419	Black	10.60		431090.5595	3974283.0899	17.06
7420	Yellow	9.80		431090.8375	3974283.2988	16.97
7421	Red	19.30		431091.2386	3974282.7275	17.65
7422	Grey	9.60		431091.4848	3974282.8933	17.60
7423	Black	9.80		431091.4665	3974282.9313	17.56
7424	Black	55.00		431091.6552	3974283.5699	17.05
7425	Black	9.70		431092.9991	3974281.2904	19.69
7426	Black	34.00		431092.0167	3974284.0131	16.81
7427	Black	25.70		431092.7829	3974284.8808	16.43
7428	Black	56.00		431094.9805	3974283.4268	18.83
7429	Black	9.00		431094.7686	3974284.2523	18.03
7430	Grey	53.60		431094.0338	3974286.5388	15.76
7431	Black	13.70		431094.6320	3974286.4098	16.23
7432	Black	7.00		431094.1342	3974286.8848	15.55
7433	Black	11.00		431094.6758	3974287.1356	15.70
7434	Black	17.60		431096.6280	3974286.4976	17.50
7435	Black	14.00		431099.0325	3974285.1635	20.15
7436	Black	20.40		431095.1040	3974287.8251	15.48
7437	Black	12.00		431096.7223	3974288.4345	16.24
7438	Yellow	20.00		431094.1454	3974280.5647	20.86
7439	Red	18.00		431096.1139	3974281.5691	21.01
7440	Yellow	15.90		431098.4599	3974283.0266	21.29
7441	Yellow	10.40		431099.4237	3974283.5636	21.55
7442	Yellow	11.90		431102.5433	3974285.1703	22.82
7443	Black	18.80		431102.9380	3974286.2880	22.49
7444	Black	6.80		431102.5702	3974286.4209	22.11
7445	Black	16.80		431102.8628	3974286.7055	22.19

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
7446	Yellow	23.00		431104.6252	3974286.9216	23.57
7447	Yellow	37.70		431105.4229	3974287.0012	24.22
7448	Grey	7.30		431105.1877	3974287.3694	23.83
7449	Yellow	13.00		431103.9661	3974288.0447	22.44
7450	Yellow	44.00		431103.7367	3974289.2763	21.66
7451	Yellow	13.00		431102.0776	3974290.5993	19.59
7452	Black	7.00		431097.8784	3974290.3252	16.04
7453	Yellow	18.00		431096.9647	3974290.6191	15.12
7454	Yellow	9.50		431096.9434	3974290.7908	15.00
7455	Black	4.50		431099.4777	3974291.5699	16.82
7456	Yellow	7.00		431102.6940	3974288.9863	20.87
7457	Yellow	10.00		431102.6832	3974288.1678	21.26
7458	Yellow	7.00		431102.4384	3974288.0366	21.12
7459	Black	8.50		431106.4125	3974292.6633	22.92
7460	Black	33.00		431100.5243	3974293.0089	17.22
7461	Black	31.20		431101.1808	3974294.4459	17.40
7462	Black	5.70		431101.5420	3974293.7482	17.95
7463	Black	14.60		431102.0514	3974294.2681	18.29
7464	Black	107.80		431101.2260	3974295.3469	17.24
7465	Black	17.00		431101.5439	3974295.3177	17.55
7466	Green	9.00		431101.0728	3974296.4252	16.89
7467	Black	17.60		431102.4291	3974295.9476	18.30
7468	Black	39.00		431103.2984	3974297.3712	18.99
7469	Black	28.60		431103.6064	3974299.0052	19.23
7470	Black	8.40		431102.5636	3974300.6073	18.25
7471	Red	10.00		431102.9672	3974300.8955	18.68
7472	Black	17.10		431101.6946	3974305.0657	18.35
7473	Black	10.70		431100.7644	3974303.7568	17.06
7474	Black	27.00		431099.9656	3974304.8957	16.66
7475	Green	40.20		431100.8646	3974305.8993	17.87
7476	Black	12.90		431101.7773	3974307.3351	19.29
7477	Black	81.50		431100.3123	3974277.9108	26.43
7478	Black	18.00		431101.9159	3974279.4395	26.27
7479	Yellow	18.70		431099.0765	3974280.7355	23.44
7480	Yellow	8.00		431099.0098	3974281.4676	22.83
7481	Yellow	8.00		431098.6168	3974280.8973	23.03
7482	Yellow	15.00		431097.0553	3974279.3763	23.36
7483	Black	10.00		431095.7329	3974278.1079	23.77
7484	Yellow	18.30		431092.7900	3974279.1838	21.52

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
7485	Black	14.90		431095.1221	3974277.2233	24.28
7486	Yellow	28.50		431094.1315	3974274.3069	26.54
7487	Yellow	5.00		431096.4974	3974280.6287	22.00
7488	Black	24.50		431090.3414	3974275.4762	24.26
7489	Yellow	6.50		431101.2916	3974281.4302	24.38
7490	Green	9.30		431107.2614	3974298.7505	22.88
7491	Grey	13.00		431097.5734	3974310.6469	17.60
7492	Black	11.00		431073.7075	3974319.7445	23.33
7493	Black	67.00		431062.8363	3974318.7801	29.25
7494	Black	6.50		431064.1285	3974314.9462	25.78
7495	Black	6.00		431063.6541	3974313.9165	25.54
7496	Black	5.00		431060.4523	3974314.9521	28.76
7497	Black	9.00		431058.4009	3974312.1642	29.13
7498	Black	40.00		431061.0910	3974310.2986	25.89
7499	Black	48.00		431058.6591	3974309.9893	27.97
7500	Black	4.90		431056.3878	3974299.5680	28.00
7501	Red	22.60		431056.2931	3974294.5057	28.44
7502	Green	8.60		431057.8002	3974297.3670	26.63
7503	Black	8.00		431055.4429	3974287.4718	31.15
7504	Black	15.00		431058.8432	3974276.7831	33.85
7505	Red	6.30		431066.6622	3974275.6729	29.29
7506	Red	6.30		431067.4674	3974276.1043	28.46
7507	Red	5.00		431070.8855	3974272.4508	29.78
7508	Red	56.00		431073.9603	3974273.0492	27.96
7509	Black	6.90		431075.7952	3974274.4000	26.05
7510	Red	7.00		431076.4268	3974275.0793	25.20
7511	Black	25.00		431075.5337	3974276.0012	24.64
7512	Red	73.00		431074.7276	3974276.8529	24.15
7513	Black	9.70		431075.4426	3974273.8851	26.65
7514	Grey	5.00		431072.7259	3974274.3342	27.28
7515	Black	31.00		431073.2212	3974274.2569	27.14
7516	Red	5.40		431070.1767	3974270.1212	32.18
7517	Black	17.00		431067.4009	3974278.5609	26.57
7518	Black	18.50		431064.4989	3974276.8186	29.78
7519	Grey	7.40		431079.8441	3974275.2607	24.16
7520	Red	16.50		431073.5649	3974272.5268	28.59
7521	Black	37.00		431065.7310	3974290.5098	20.49
7522	Black	13.00		431065.8659	3974290.5685	20.34
7523	Black	17.00		431066.5791	3974291.2059	19.43

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
7524	Black	8.00		431066.9661	3974291.0647	19.14
7525	Black	11.60		431065.3604	3974290.2651	20.93
7526	Black	5.00		431061.1101	3974277.8649	31.43
7527	Black	12.00		431067.2005	3974300.7687	17.27
7528	Black	6.00		431076.5198	3974301.8133	8.35
7529	Black	5.50		431073.7193	3974299.0385	10.66
7530	Black	5.70		431079.5139	3974302.5274	6.01
7531	Black	18.00		431080.2538	3974305.2041	7.46
7532	Black	5.00		431079.8249	3974303.5132	6.42
7533	Black	6.50		431079.7874	3974303.0300	6.11
7534	Black	6.00		431079.3894	3974302.3324	6.00
7535	Black	6.00		431078.3959	3974302.1008	6.74
7536	Black	6.00		431076.6077	3974303.7664	9.12
7537	Black	6.00		431057.2688	3974292.9709	27.77
7538	Red	5.50	and green cp something	431053.7502	3974287.9541	32.56
7539	Black	5.70		431072.2838	3974302.1297	12.50
7540	Black	5.00		431077.0406	3974313.3783	16.15
7541	Black	9.50		431076.8532	3974313.4427	16.29
7542	Black	5.00		431077.4005	3974311.0687	13.95
7543	Black	63.00		431207.7206	3974305.6347	123.52
7544	Yellow	35.80		431178.4104	3974290.5882	94.40
7545	Green	116.00		430969.4862	3974386.9582	144.70
7546	Green	4.70		431105.2146	3974281.5896	27.15
7547	Yellow	14.60		431105.6633	3974281.3032	27.68
7548	Grey	34.50		431110.1441	3974279.2835	32.44
7549	Grey	10.40		431110.1956	3974280.3879	31.82
7550	Yellow	28.30		431103.1761	3974279.8996	26.79
7551	Yellow	11.70		431104.1201	3974282.4524	25.75
7552	Yellow	11.70		431114.7601	3974277.6477	37.13
7553	Yellow	15.20		431115.5197	3974277.3992	37.89
7554	Yellow	4.80		431114.4030	3974278.9992	36.07
7555	Yellow	24.50		431112.1631	3974282.2873	32.42
7556	Yellow	5.80		431111.4783	3974283.3644	31.28
7557	Yellow	10.50		431105.8681	3974284.5243	25.91
7558	Yellow	10.70		431107.9336	3974283.8955	27.98
7559	Yellow	4.50		431107.0462	3974283.6831	27.35
7560	Yellow	12.80		431109.9188	3974284.5266	29.35
7561	Yellow	7.30		431109.6690	3974282.9793	29.93
7562	Yellow	6.90		431109.9125	3974282.9182	30.17

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
7563	Yellow	7.70		431110.8096	3974287.9670	28.64
7564	Yellow	12.30		431116.3828	3974283.1071	35.73
7565	Yellow	21.90		431113.6859	3974277.5723	36.30
7566	Yellow	5.80		431112.6196	3974277.5138	35.48
7567	Yellow	5.80		431109.9167	3974286.3408	28.50
7568	Yellow	8.40		431114.1714	3974277.0013	37.03
7569	Yellow	20.40		431113.6113	3974277.2667	36.42
7570	Yellow	18.90		431115.3998	3974284.6472	34.18
7571	Yellow	6.40		431114.1396	3974283.7196	33.45
7572	Yellow	24.90		431117.1668	3974276.4293	39.80
7573	Yellow	9.60		431116.3845	3974274.6945	40.18
7574	Yellow	25.60		431109.5511	3974284.8118	28.89
7575	Yellow	17.10		431114.5001	3974275.4529	38.23
7576	Yellow	5.40		431109.6375	3974279.8091	31.72
7577	Yellow	11.70		431108.6282	3974284.4430	28.28
7578	Yellow	8.50		431107.9886	3974283.3964	28.30
7579	Yellow	47.00		431111.2125	3974278.4140	33.82
7580	Grey	13.60		431106.8153	3974281.9579	28.17
7581	Yellow	8.00		431107.8586	3974281.0129	29.57
7582	Yellow	12.60		431107.0790	3974280.3688	29.36
7583	Grey	5.00		431107.5387	3974279.7601	30.10
7584	Yellow	4.90		431112.1378	3974275.9261	36.09
7585	Yellow	25.30		431116.9079	3974270.2325	43.42
7586	Yellow	141.10		431113.2343	3974269.2187	41.46
7587	Yellow	166.30		431110.3166	3974270.7115	38.37
7588	Yellow	142.70		431109.4774	3974270.4279	38.02
7589	Yellow	16.40		431111.7060	3974272.0892	38.35
7590	Yellow	9.00		431109.6948	3974275.3572	34.63
7591	Yellow	74.40		431105.9301	3974268.8994	37.01
7592	Yellow	16.90		431107.2130	3974271.7360	35.56
7593	Yellow	4.80		431107.7956	3974274.8155	33.66
7594	Grey	11.80		431106.8797	3974273.7274	33.83
7595	Grey	10.60		431106.8676	3974268.6240	37.79
7596	Yellow	11.30		431103.0993	3974268.2652	35.98
7597	Red	9.70		431104.0449	3974275.3198	30.78
7598	Grey	28.20		431102.6165	3974274.2862	30.71
7599	Yellow	30.60		431103.3984	3974274.0743	31.35
7600	Black	8.90		431104.0307	3974273.0929	32.51
7601	Red	15.50		431104.4852	3974262.7776	41.42

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
7602	Yellow	17.00		431104.7623	3974264.3113	40.23
7603	Red	111.30		431107.1676	3974262.1186	43.35
7604	Yellow	4.60		431107.8047	3974259.2258	46.15
7605	Grey	107.30		431102.5485	3974272.3202	32.27
7606	Yellow	15.60		431101.8268	3974273.9763	30.50
7607	Yellow	38.90		431100.8990	3974277.3899	27.20
7608	Yellow	54.40		431098.1475	3974275.3673	27.35
7609	Yellow	26.00		431099.2249	3974273.8373	29.21
7610	Yellow	17.80		431100.1459	3974274.4999	29.13
7611	Grey	19.60		431100.9315	3974270.9574	32.56
7612	Yellow	14.30		431101.6125	3974274.4988	29.95
7613	Yellow	20.40		431104.2883	3974270.1372	35.06
7614	Yellow	29.00		431110.5513	3974266.6565	41.60
7615	Yellow	7.90		431111.8991	3974266.2415	42.78
7616	Yellow	66.00		431113.7843	3974266.1652	44.07
7617	Yellow	64.30		431101.1681	3974263.4153	39.34
7618	Black	22.40		431101.1704	3974264.6688	38.21
7619	Yellow	12.00		431102.9372	3974272.9091	32.01
7620	Yellow	18.70		431101.8323	3974278.8339	26.66
7621	Yellow	8.60		431102.0983	3974279.4123	26.41
7622	Yellow	8.10		431102.9049	3974278.9613	27.28
7623	Yellow	6.20		431103.0281	3974279.1430	27.24
7624	Yellow	34.40		431099.6331	3974264.9865	37.27
7625	Yellow	4.50		431102.5873	3974262.7809	40.53
7626	Grey	9.30		431109.1340	3974260.9201	45.41
7627	Yellow	6.30		431107.7577	3974264.4881	41.68
7628	Yellow	21.90		431106.8465	3974271.9103	35.19
7629	Yellow	14.10		431102.2954	3974276.6596	28.63
7630	Yellow	12.60		431101.8360	3974278.6573	26.80
7631	Yellow	6.20		431099.2911	3974274.3626	28.79
7632	Yellow	8.40		431095.7594	3974276.1918	25.48
7633	Other	20.40	rebar	431097.2752	3974276.1528	26.23
7634	Yellow	9.90		431097.3832	3974280.6518	22.48
7635	Yellow	7.30		431098.0320	3974280.4903	22.99
7636	Yellow	6.00		431097.2120	3974280.6462	22.39
7637	Red	8.30		431095.2727	3974278.4505	23.25
7638	Black	9.30		431095.3139	3974278.3436	23.37
7639	Yellow	19.00		431100.8570	3974268.6698	34.51
7640	Yellow	22.90		431089.5038	3974275.5385	24.01

TABLE V-G-1. (Contd.)

Object ID	Color	Mass	Notes	XUTM	YUTM	Distance From Door, meters
7641	Black	35.10		431089.7866	3974274.0327	25.54
7642	Black	5.80		431085.0822	3974273.8232	25.18
7643	Grey	5.10		431087.3331	3974269.1141	30.03
7644	Yellow	8.90		431088.1225	3974276.6203	22.68
7645	Red	5.60		431093.0281	3974279.5661	21.27
7646	Black	7.60		431097.2849	3974281.5751	21.68
7647	Yellow	10.40		431095.9524	3974281.1336	21.28
7648	Red	14.50		431073.9770	3974270.4484	30.38
7649	Red	5.30		431062.3327	3974275.3582	32.32
7650	Red	5.40		431064.0823	3974277.4811	29.58
7651	Red	4.80		431052.5616	3974278.8243	37.67
7652	Red	7.20		431051.7895	3974279.4642	38.00
7653	Red	5.20		431058.2124	3974274.0023	36.19
7654	Red	4.90		431071.0440	3974265.9973	35.59
7655	Red	4.70		431063.4011	3974272.7345	33.61
7656	Red	6.00		431063.2095	3974277.3739	30.26
7657	Black	4.70		431063.7304	3974276.6062	30.46
7658	Black	8.80		431066.5549	3974277.3286	28.06
7659	Black	5.50		431077.2394	3974315.1983	17.71
7660	Black	15.40		431145.5444	3974400.6285	118.62
7661	Black	5.10		431124.3313	3974364.5130	76.74
7662	Black	13.10		431102.9694	3974330.7484	36.79
7663	Grey	11.80		431095.4426	3974310.4307	15.91

FRAGMENT MAPS FOR EACH OF THE WEIGHT GROUPS AND PHOTOGRAPHS OF SIGNIFICANT DEBRIS FRAGMENTS

This section presents the fragment maps for each of the weight groups presented in Chapter V in Figure V-39 and Figure V-40.

Figures V-G-1 through V-G-48 present the fragment map for Test 4 with the fragment(s) in the weight category highlighted by red data points. Photographs of significant debris fragments in the weight group are also shown for the larger fragments.

The fragment map for fragments having weight greater than 8,000 g is presented in Figure V-G-1. The largest fragment, weighing 11,555 g, was found 31.5 m from the center of the original structure. The largest fragment came from the roof and is shown in Figure V-G-2. The other three large fragments having weights greater than 8,000 g are shown in Figures V-G-3, V-G-4, and V-G-5.

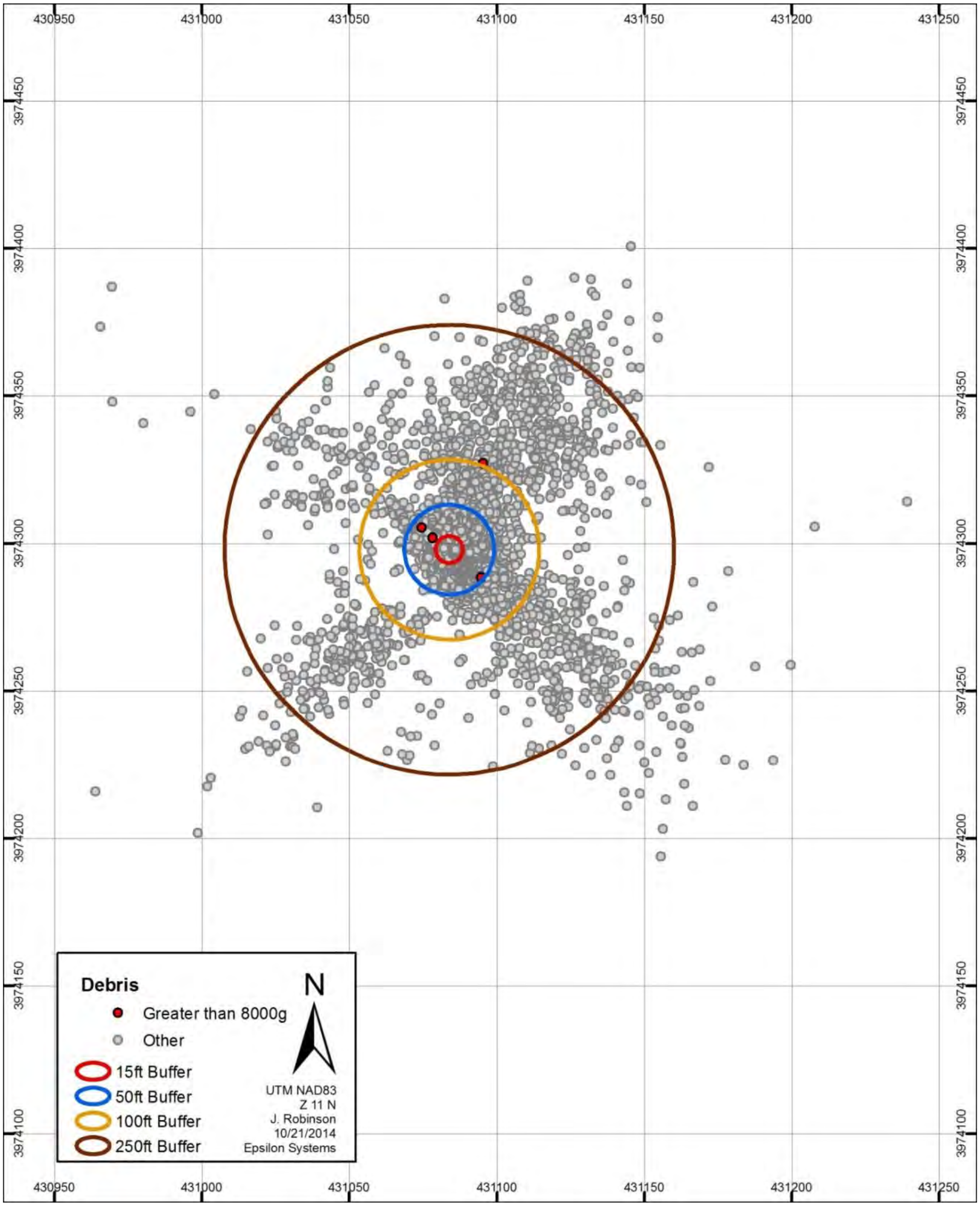

FIGURE V-G-1. Fragment Map of Fragments Having Weight Greater Than 8,000 g (Test 4).

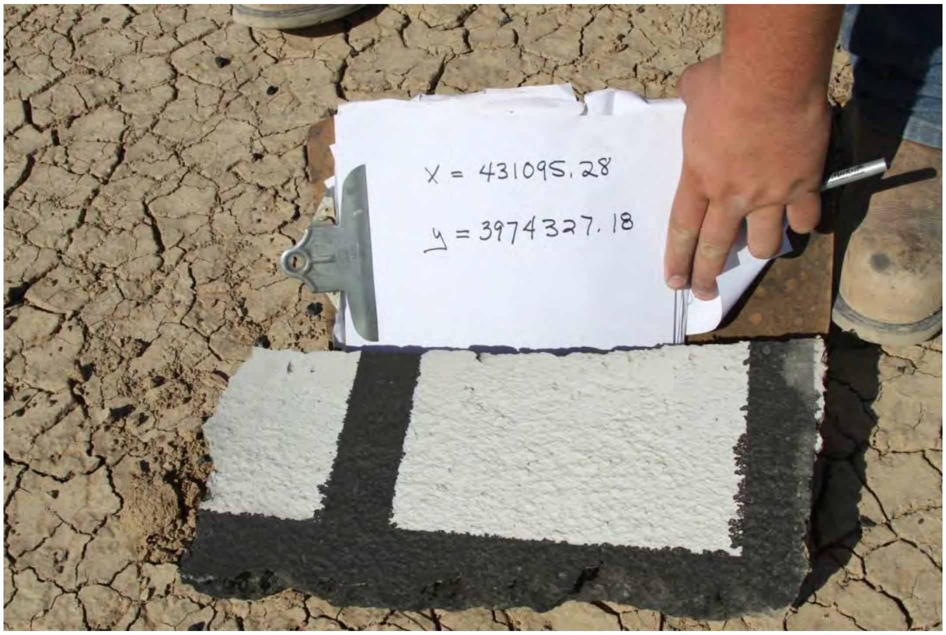

FIGURE V-G-2. Fragment From the Roof Weighing 11,555 g Found
31.5 m From Center of Original Structure (Test 4).

FIGURE V-G-3. Fragment From the Roof Weighing 8,790 g Found
22.2 m From Center of Original Structure (Test 4).

FIGURE V-G-4. Fragment From Front Wall Weighing 8,750 g and Found 17.5 m From Center of Original Structure (Test 4).

FIGURE V-G-5. Roof Fragment Weighing 8,740 g Found 14.25 m From Center of Original Structure (Test 4).

Figure V-G-6 presents the fragment map for the weight range 7,000 to 7,999.9 g. This figure has the single roof fragment weighing 7,100 g that was found 1.84 m from center of original structure.

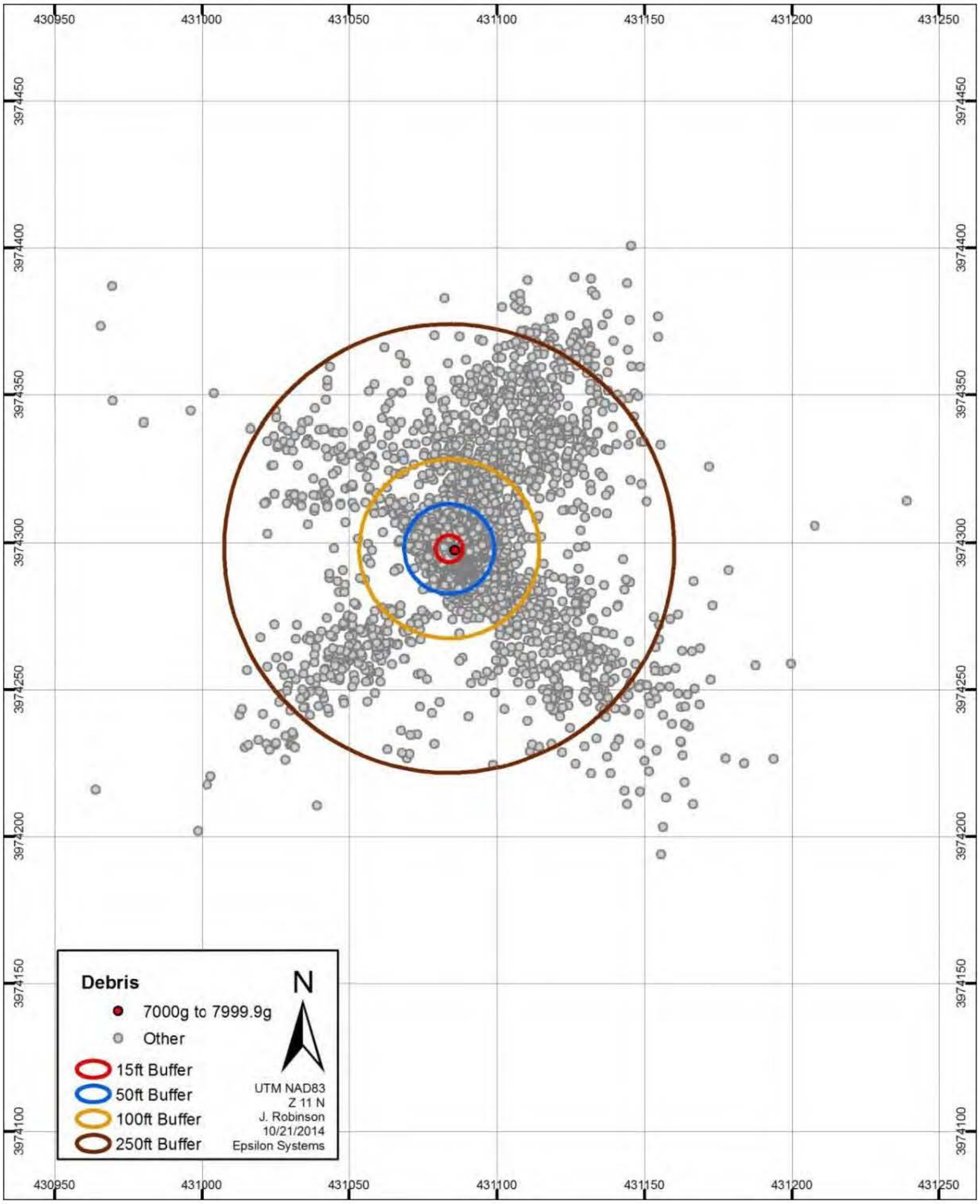

FIGURE V-G-6. Fragment Map Showing the Single Fragment in the 7,000- and 7,999.9-g Weight Range (Test 4).

Figure V-G-7 presents the fragment map for fragments having weight between 6,000 and 6,999.9 g. The three fragments were all from the roof and had the following weights: 6,375 g (Figure V-G-8) and was found 22.2 m from the center of the structure, 6,325 g (Figure V-G-9) and was found 11.8 m from the center of the structure, and 6,110 g and was found 1.9 m from the center of the structure.

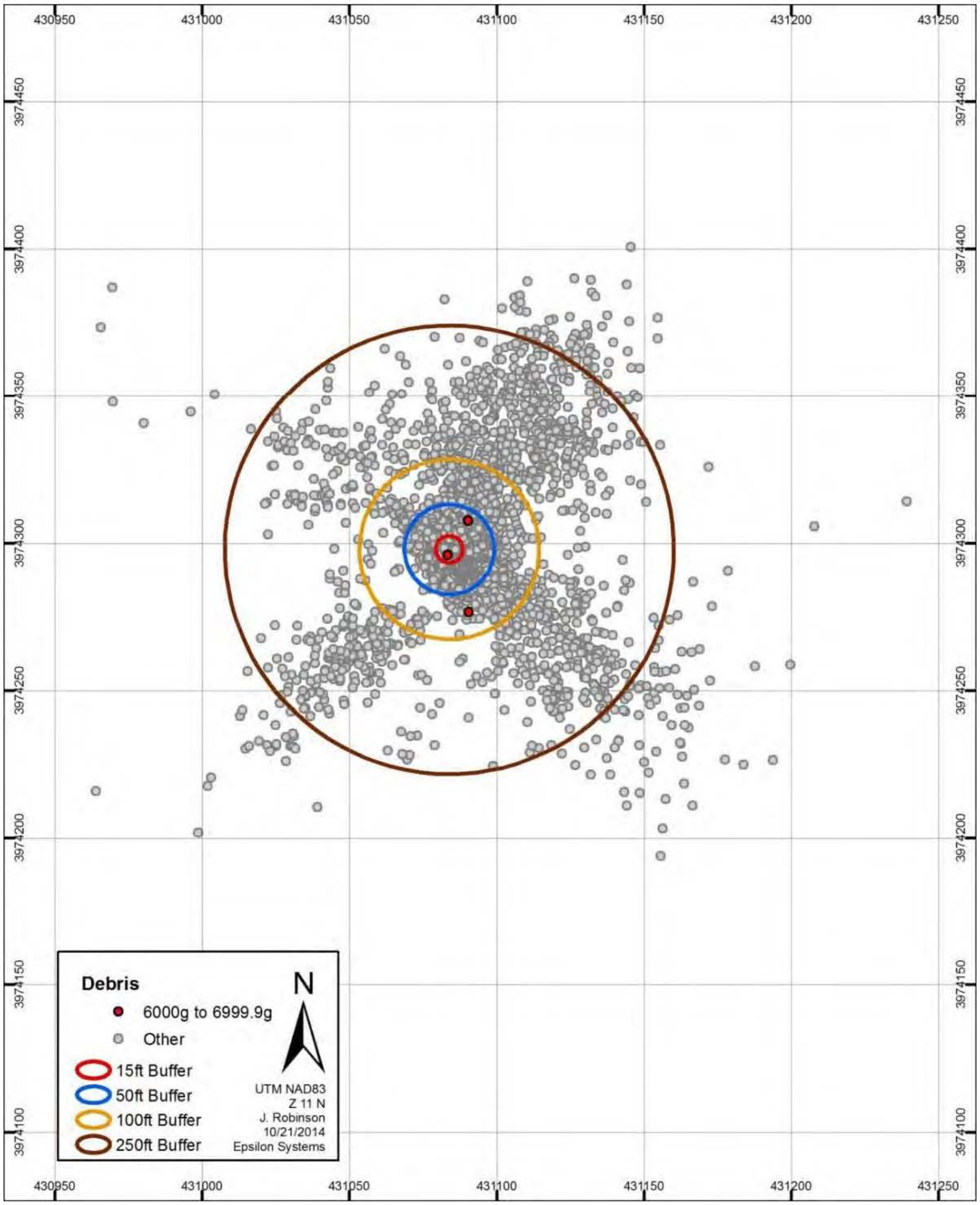

FIGURE V-G-7. Fragment Map of Fragments Having Weights Between 6,000 and 6,999.9 g (Test 4).

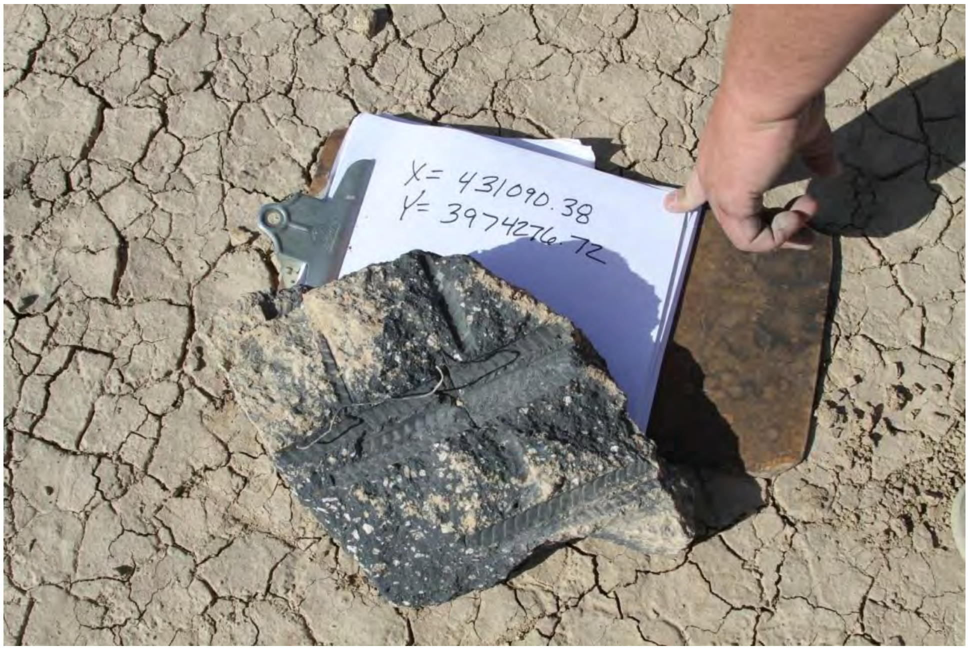

FIGURE V-G-8. Roof Fragment Weighing 6,375 g Found
22.2 m From Center of Structure (Test 4).

FIGURE V-G-9. Roof Fragment Weighing 6,325 g Found
11.8 m From Center of Structure (Test 4).

Figure V-G-10 presents the fragment map showing the single fragment in the 5,000- to 5,999.9-g range. The fragment weighed 5,245 g, was from the roof, and was found 36.9 m from the center of the structure.

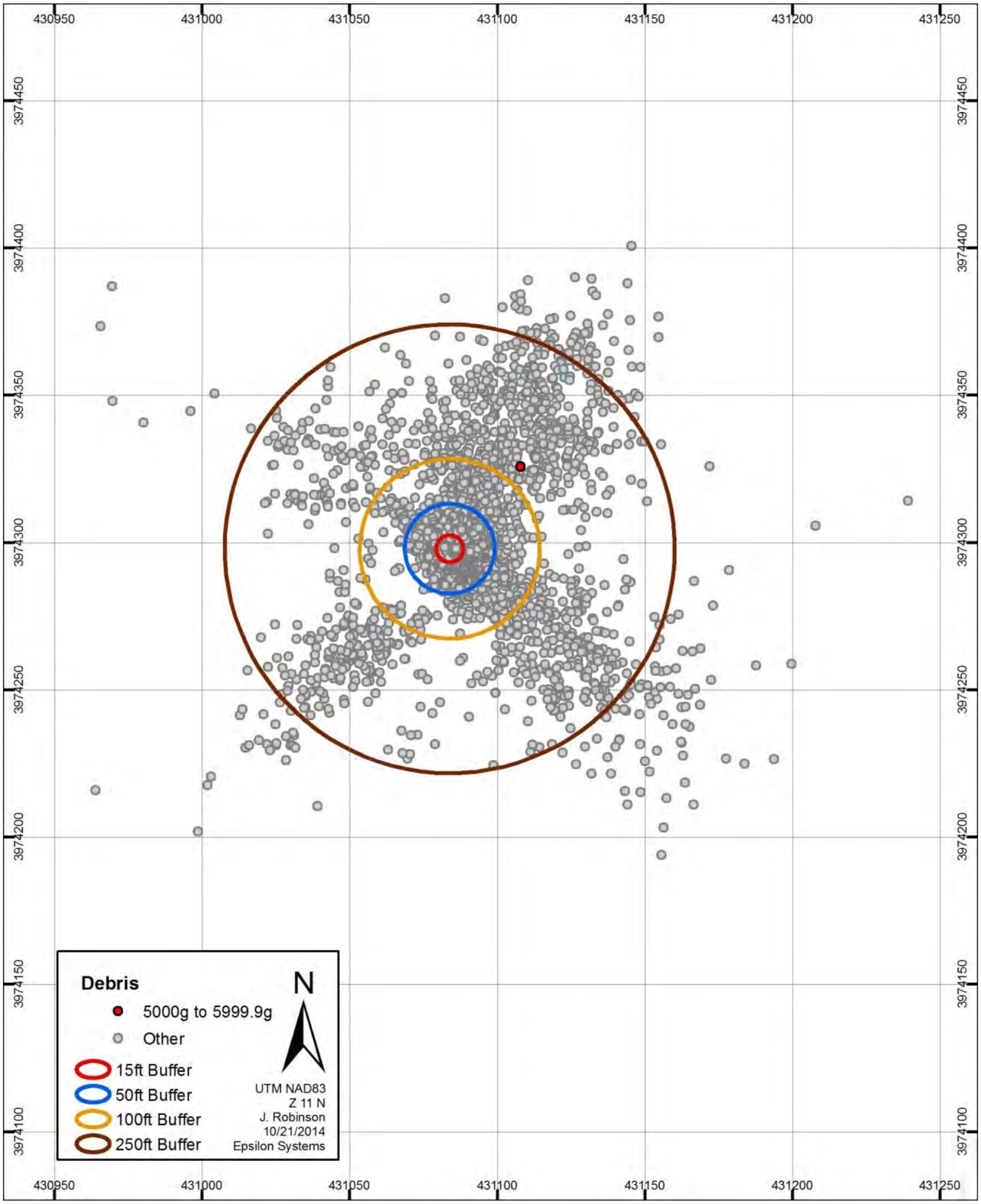

FIGURE V-G-10. Fragment Map of Fragments Having Weights Between 5,000 and 5,999.9 g (Test 4).

Figure V-G-11 presents the fragment map for fragments weighing between 4,000 and 4,999.9 g. Table V-G-2 presents the fragment weight, origin location (e.g., roof, front wall, back wall), and distance from the center of the structure where they were found. The motion pictures showed that some of the roof fragments essentially went

straight up and then down, accounting for some of the short distances from the structure. Figures V-G-12 and V-G-13 present photographs of the 4,535-g roof fragment and the 4,390-g roof fragment.

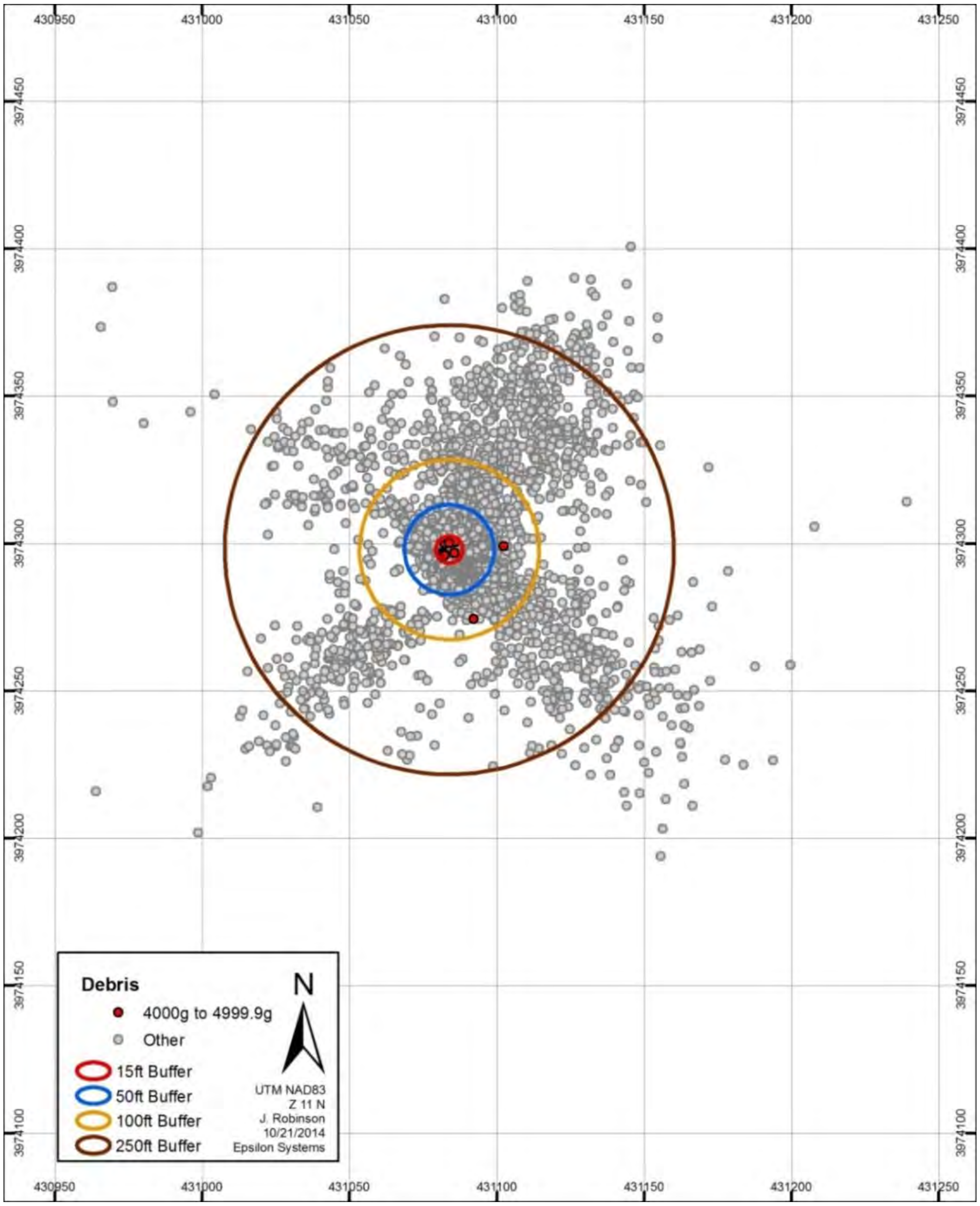

FIGURE V-G-11. Fragment Map of Fragments Weighing Between 4,000 and 4999.9 g (Test 4).

TABLE V-G-2. Fragments in the 4,000- to 5,000-g Range (Test 4).

Fragment Weight, g	Original Location	Distance From Center of Structure Where Found, m
4,920	Front wall	3.4
4,910	Front wall	2.4
4,735	Back wall	2.4
4,600	Front wall	2.4
4,555	Roof	1.7
4,535	Roof	25
4,390	Roof	18.5
4,390	Front wall	3.5
4,375	Roof	2.5
4,310	Back wall	2.4

FIGURE V-G-12. Roof Fragment Weighing 4,535 g Found
25 m From Center of Structure (Test 4).

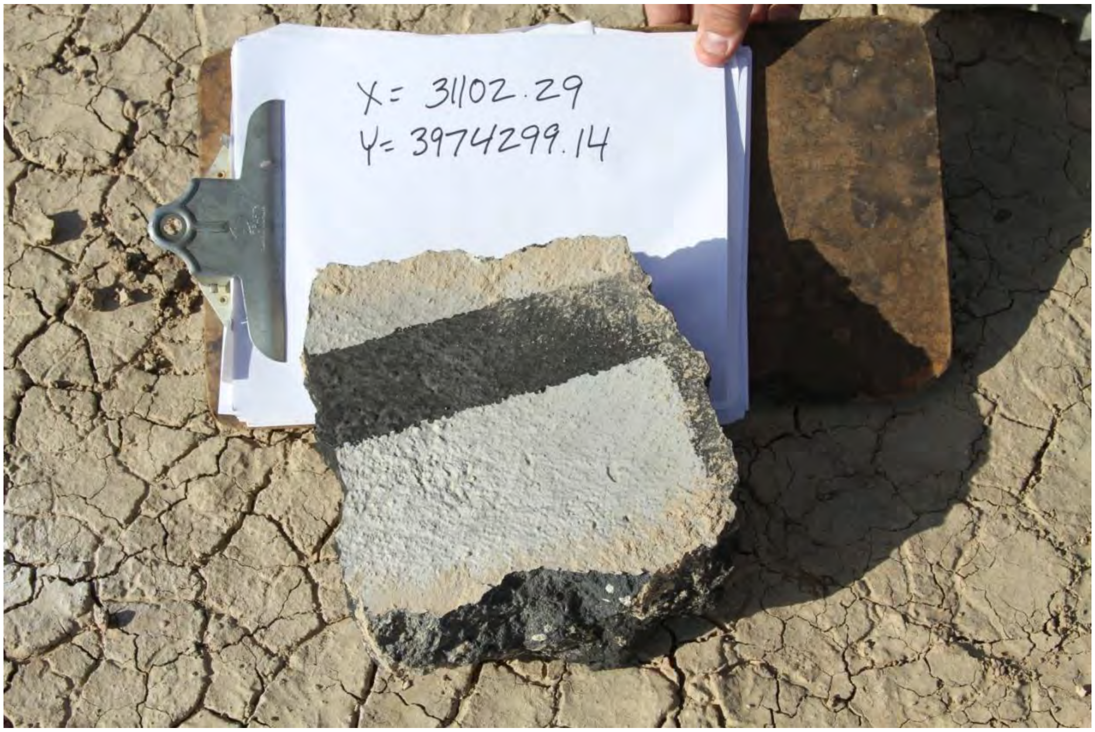

FIGURE V-G-13. Roof Fragment Weighing 4,390 g Found
3.5 m From Center of Structure (Test 4).

Figure V-G-14 presents the fragment map for fragments in the 3,000- to 3,999.9-g range. There were 28 fragments in this range with all but 6 being fragments from the roof. Four of the fragments were from the front wall, and two were from the back wall. Figures V-G-15 and V-G-16 represent two of the roof fragments. One fragment weighed 3,905 g, and the other weighed 3,535 g. Both fragments were found at distances of 22 m and 7.6 m, respectively.

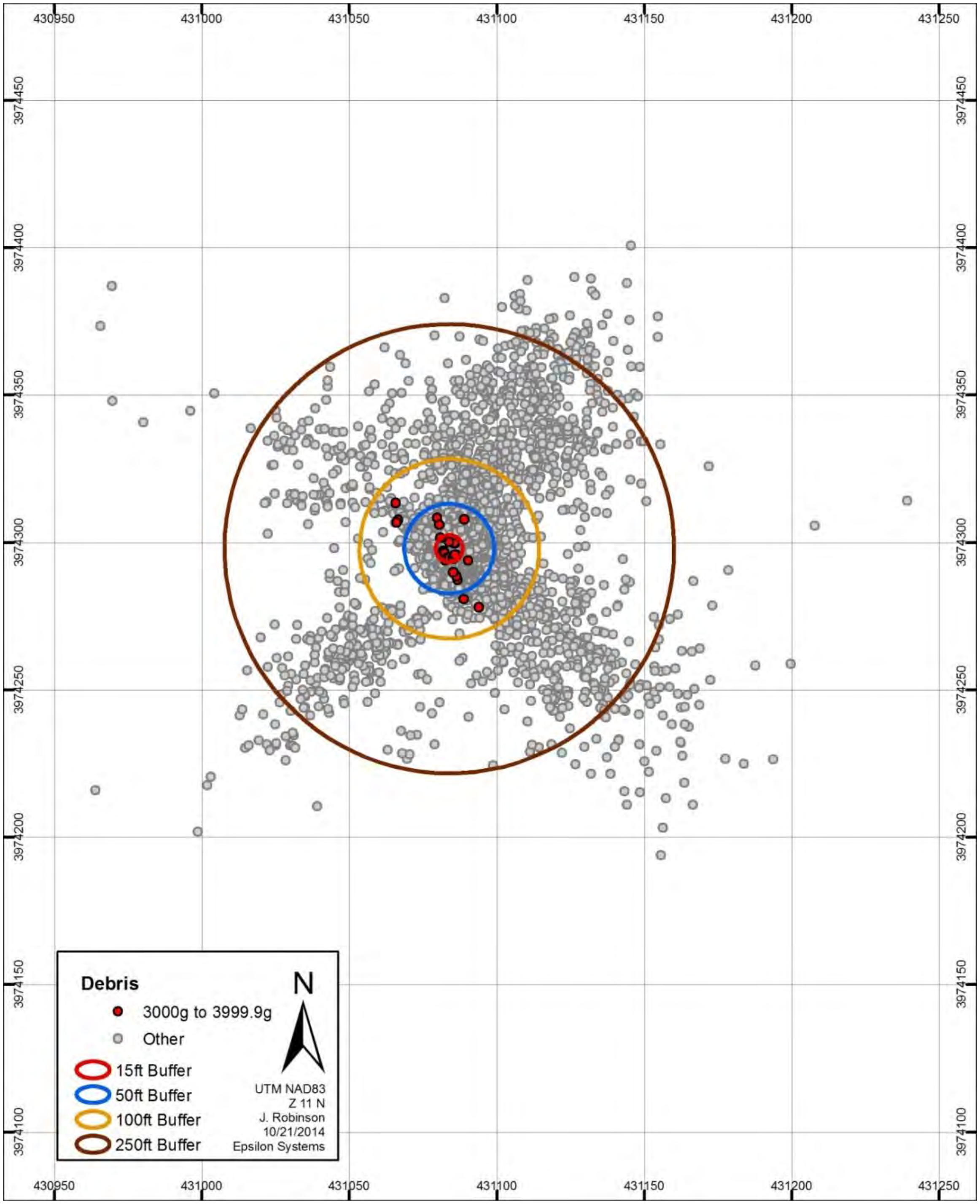

FIGURE V-G-14. Fragment Map of Fragments in the 3,000- to 3,999.9-g Weight Range (Test 4).

FIGURE V-G-15. Roof Fragment Weighing 3,905 g Found
22 m From the Center of the Structure (Test 4).

FIGURE V-G-16. Roof Fragment Weighing 3,535 g Found
7.6 m From the Center of the Structure (Test 4).

Figure V-G-17 presents the fragment map for the fragments in the 2,000- to 2,999.9-g range. There are 37 items in this range including some bare rebar fragments. The majority of fragments were from the roof, but there were five fragments from the

front wall and one fragment from the west wall. Figure V-G-18 presents a photograph of a roof fragment weighing 2,025 g found 13.8 m from the center of the structure.

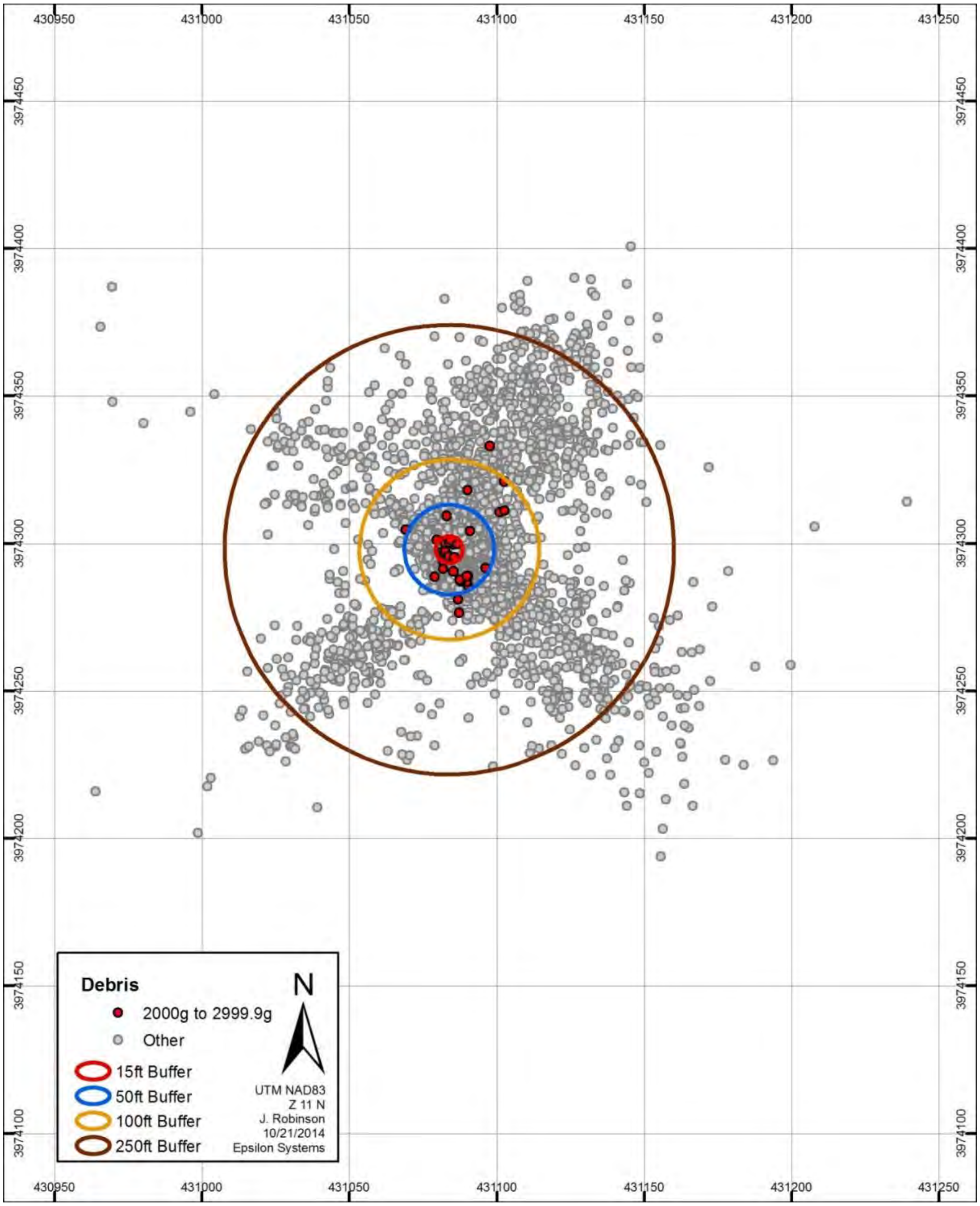

FIGURE V-G-17. Fragment Map of the 2,000- to 2,999.9-g Weight Range (Test 4).

FIGURE V-G-18. Roof Fragment Weighing 2,025 g Found
13.8 m From the Center of the Structure (Test 4).

Figure V-G-19 presents the fragment map for the 20 fragments in the range of 1,500 to 1,999.9 g. Of the 20 fragments, 13 were from the roof, 5 were from the front wall, 1 was from the back wall, and 1 was from the corner of the front and east walls. This latter fragment is shown in Figure V-G-20. The fragment was from the corner of the north and east walls, weighed 1,850 g, and was found 1.8 m from the center of the structure. As shown in Figure V-G-19, most of the fragments in the 1,500- to 1,999.9-g range were found relatively close to the structure.

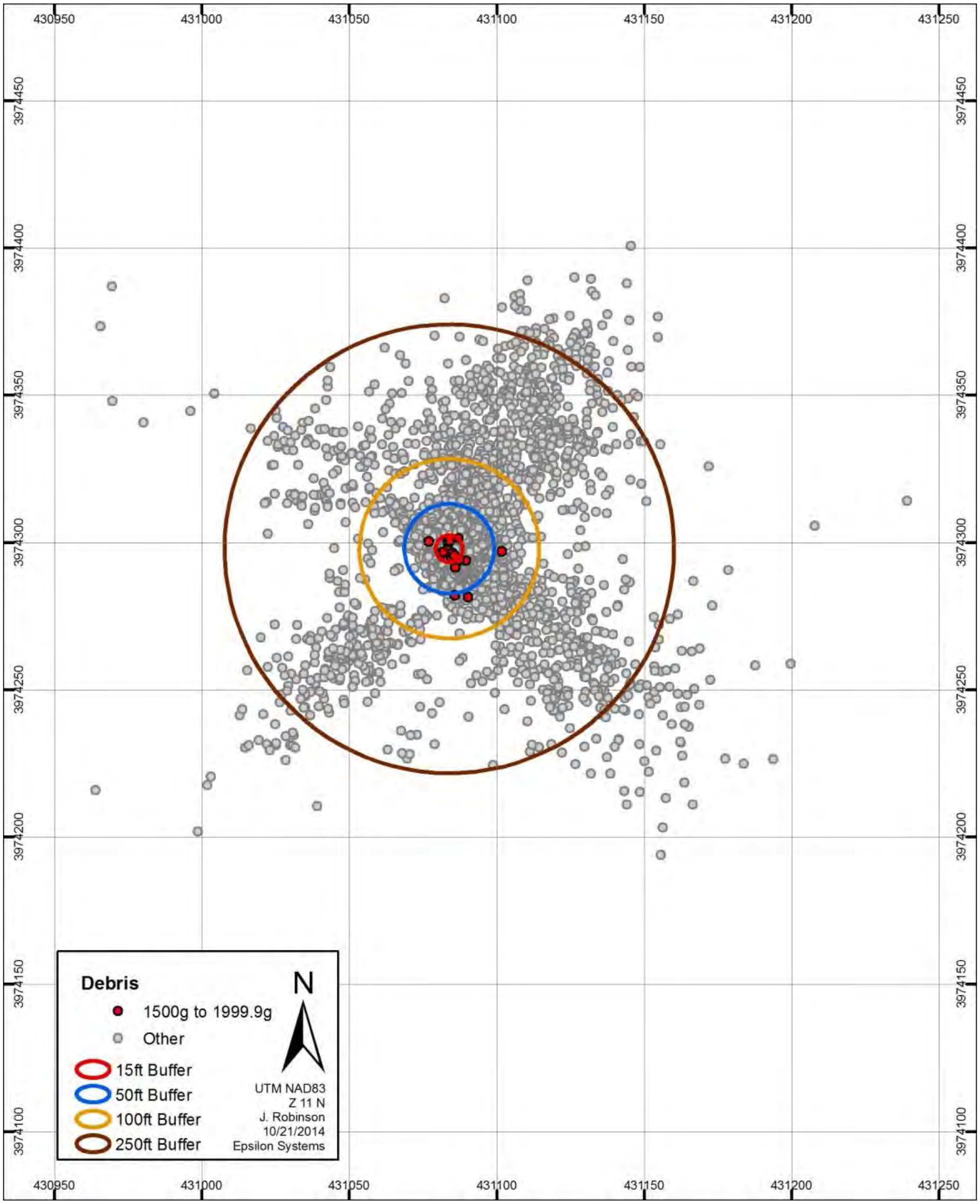

FIGURE V-G-19. Fragment Map of Fragments Weighing
Between 1,500 to 1,999.9 g (Test 4).

FIGURE V-G-20. Fragment From the Corner of the North and East Walls (Test 4).

Figure V-G-21 presents the fragment map for the 31 fragments having weight between 1,000 and 1,499.9 g. Of the 31 fragments, 25 were from the roof, 5 from the front wall, and 1 from the back wall. The fragment from the back wall, shown in Figure V-G-22, weighed 1,167.5 g and was the farthest fragment in the southwest direction at 90.7 m from the center of the structure. The farthest fragment in the northeast direction was a roof fragment shown in Figure V-61 weighing 1,029.7 g that was found 84.9 m from the center of the structure.

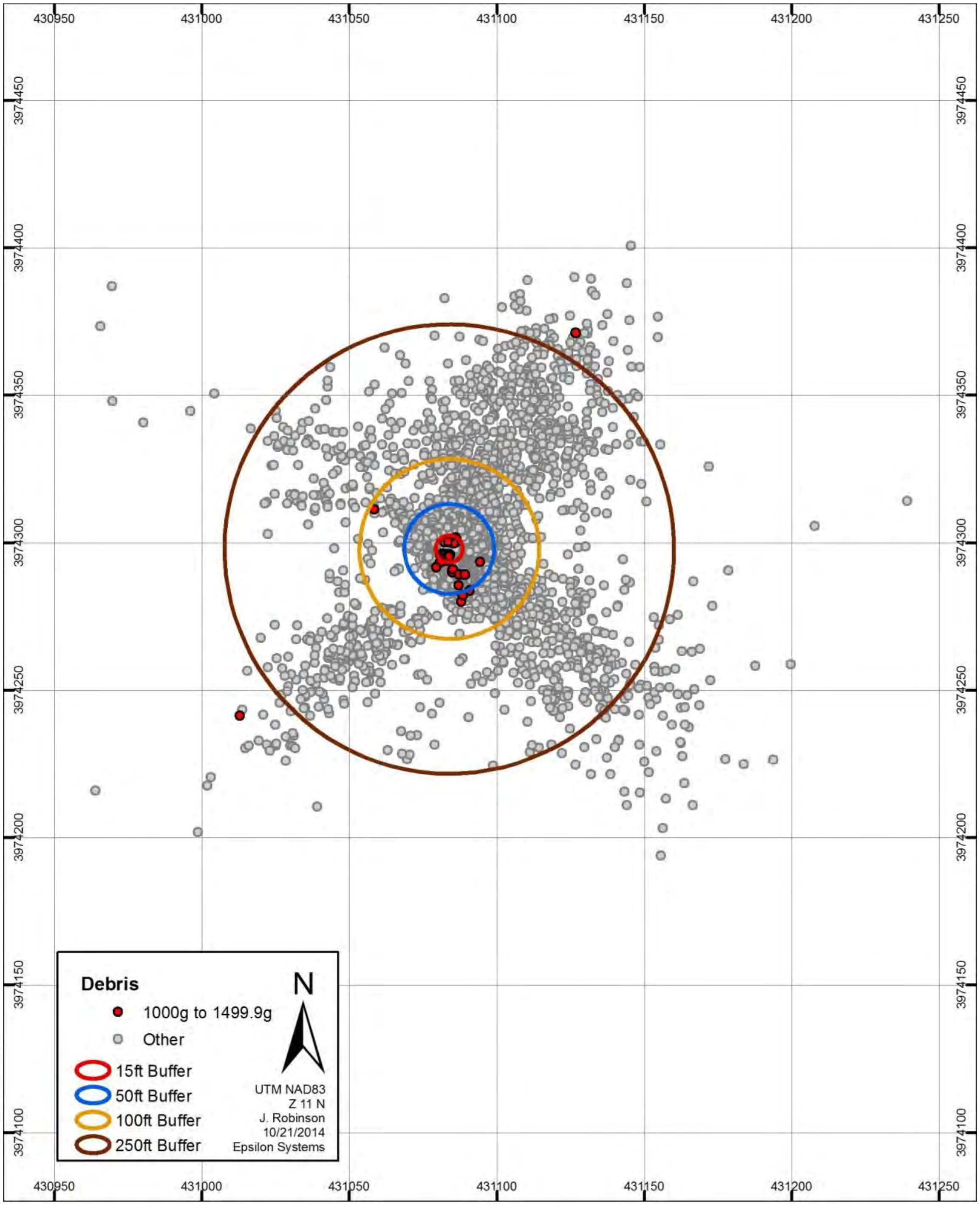

FIGURE V-G-21. Fragment Map of Fragments in the 1,000- to 1,499.9-g Range (Test 4).

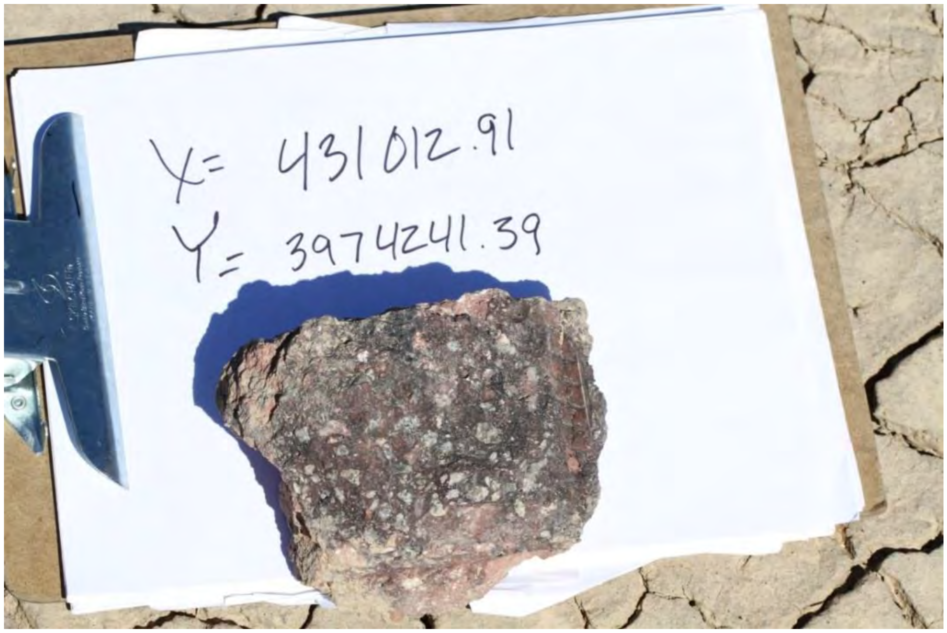

FIGURE V-G-22. Fragment From Back Wall Weighing 1,167.5 g That Was Found 90.7 m From the Center of the Structure in the Southwest Direction (Test 4).

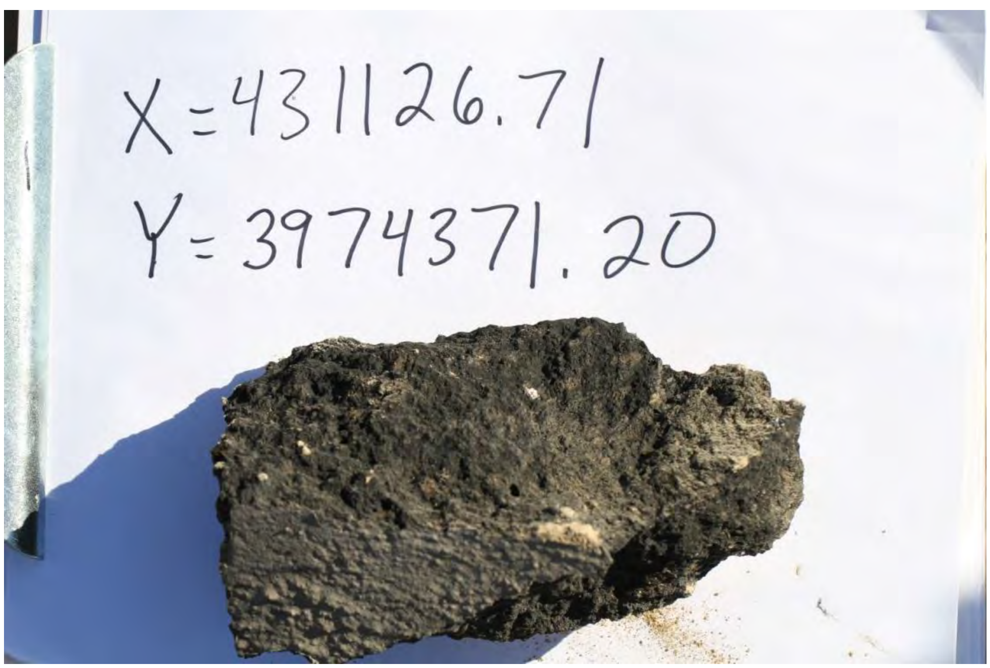

FIGURE V-G-23. Roof Fragment Weighing 1,029.7 g That Was Found 84.9 m Northeast From the Center of the Structure (Test 4).

Figure V-G-24 presents the fragment map for fragments in the 800- through 999.9-g range. Of the 35 fragments in this range, 32 were from the roof, 2 were from the front

(north) wall, and 1 was from the east wall. The fragment from the east wall is shown in Figure V-G-25. This fragment weighed 843.9 g and was found 93.9 m from the center of the structure in the southeast direction. The farthest fragment in the northeast direction was a roof fragment shown in Figure V-G-26 weighing 972.7 g and was found 71.6 m from the center of the structure.

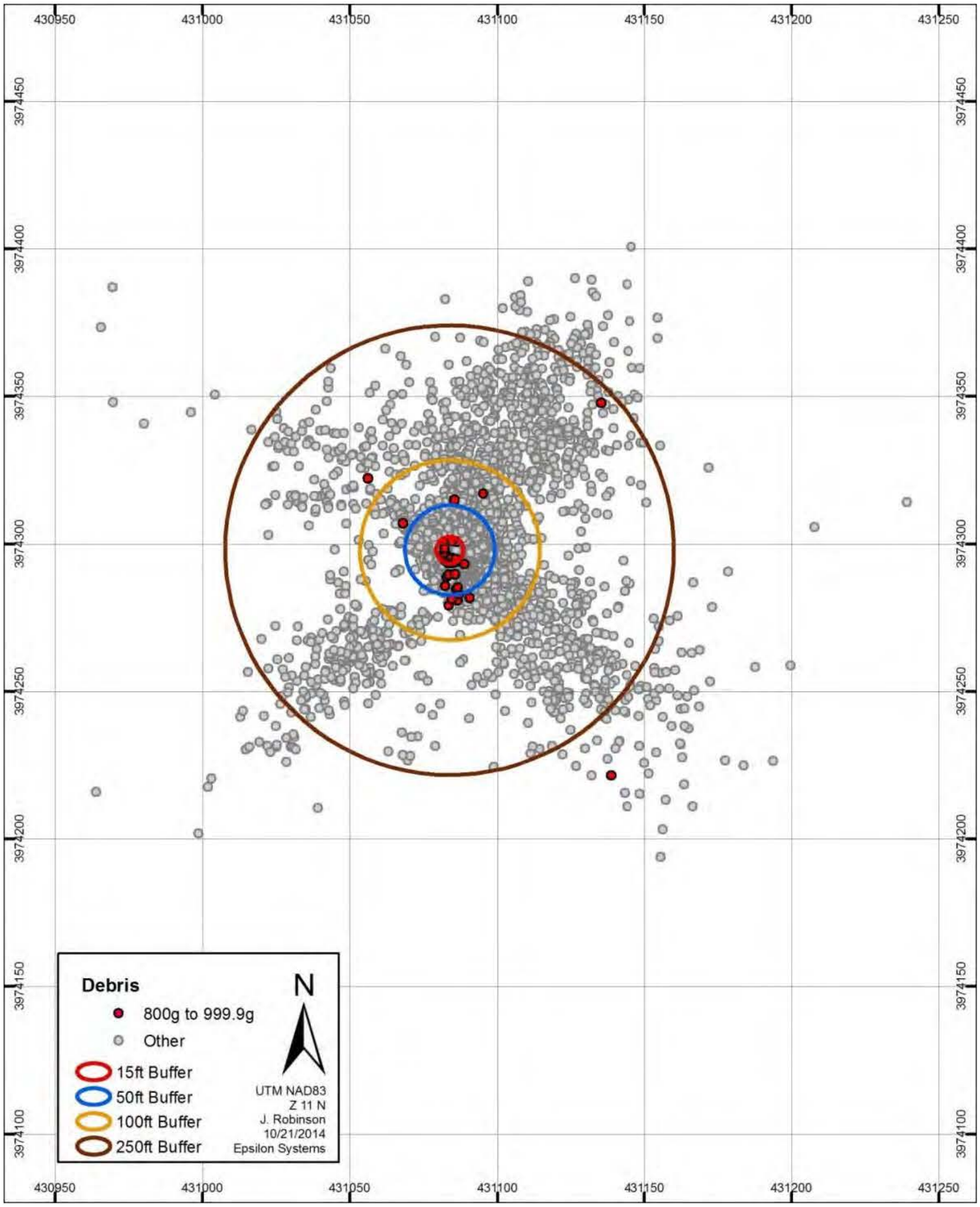

FIGURE V-G-24. Fragment Map of Fragments in the 800- to 999.9-g Range (Test 4).

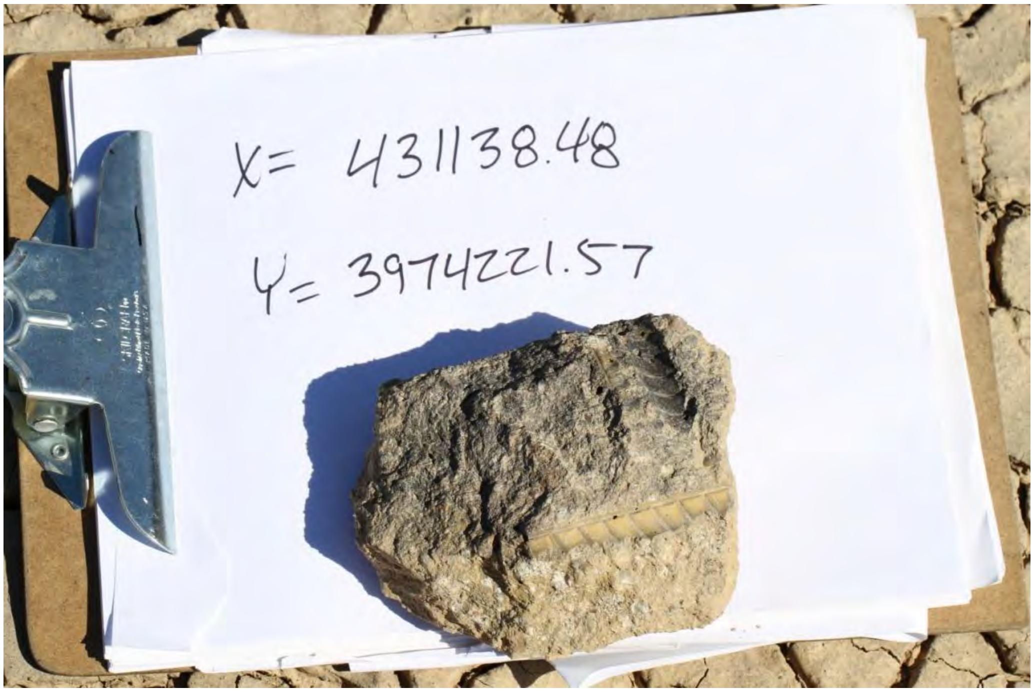

FIGURE V-G-25. Fragment From the East Wall That Weighed 843.9 g and Was Found 93.9 m Southeast From the Center of the Structure (Test 4).

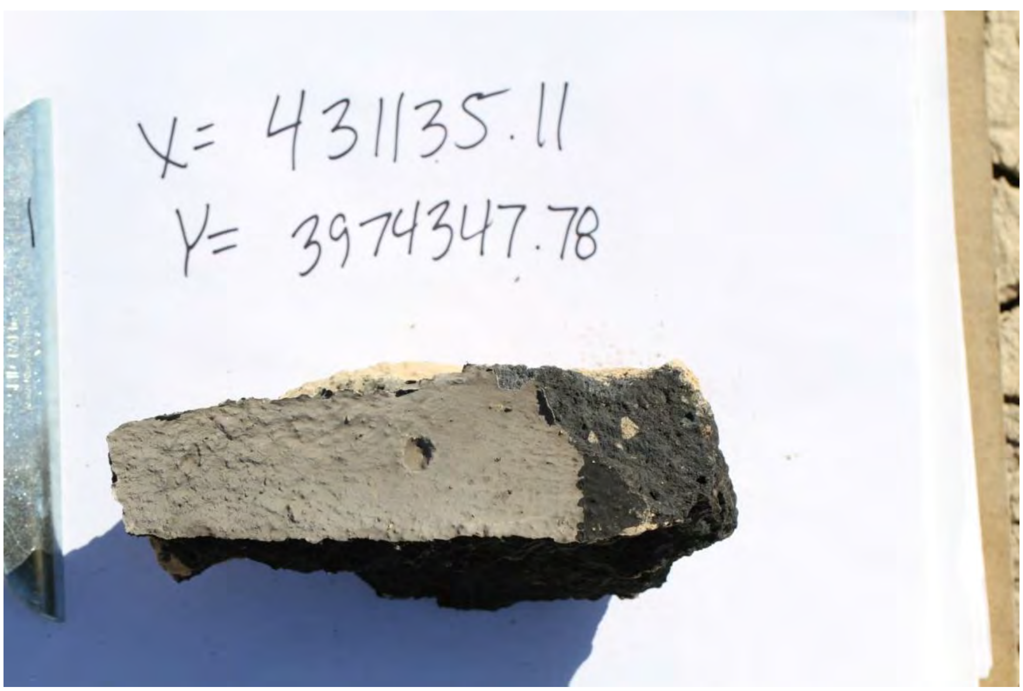

FIGURE V-G-126. Roof Fragment Weighing 972.7 g That Was Found 71.6 m Northeast of the Center of the Structure (Test 4).

Figure V-G-27 presents the fragment map for fragments in the 600- to 799.9-g range. Of the 51 fragments in this range, 44 were from the roof, 3 were from the front (north) wall, 3 were from the east wall, and 1 was from the back wall. The fragment from the back (south) wall weighed 647.3 g and was the farthest fragment in the southwest direction at 68.2 m from the center of structure. The farthest fragment in the northeast direction was a roof fragment weighing 789.7 g and was found 58.2 m from the center of the structure.

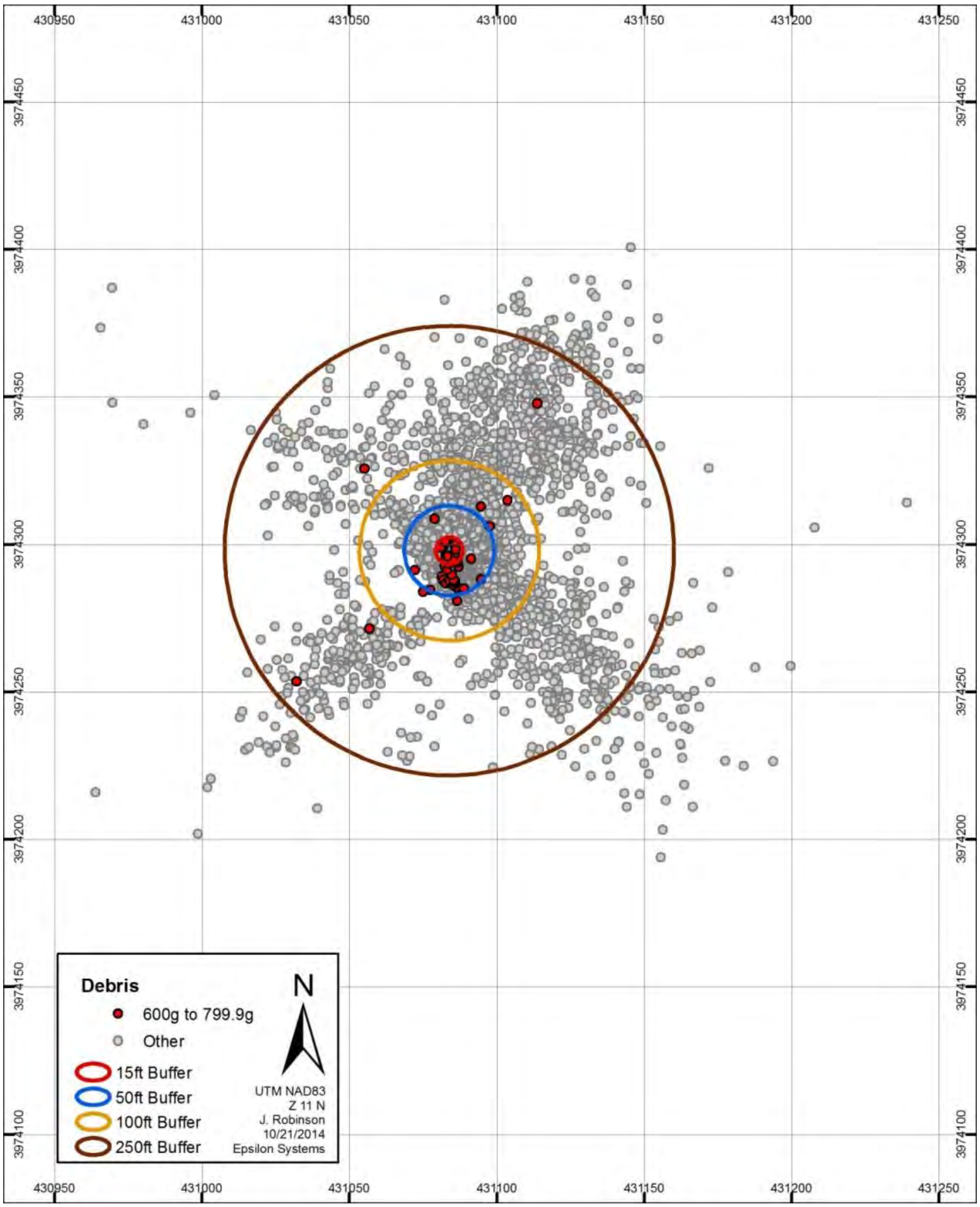

FIGURE V-G-227. Fragment Map of the 600- to 799.9-g Range (Test 4).

Figure V-G-28 presents the fragment map for the 400- to 599.9-g range. There were 77 fragments and 1 bare piece of rebar in this range. Of the 77 fragments in the 600- to 799.9-g range, 68 were from the roof, 4 from the front (north) wall, 3 from the east wall, 1 from the back (south) wall, 1 from the west wall, and 1 from the south and west wall corner. The most northwest fragment was from the west wall, weighed 434 g, and was found 140.3 m from the center of the structure. The fragment from the back (south) wall weighed 448 g and was the most southwestern fragment in this range and was found at 88.8 m from the center of the structure. One of the fragments from the east wall was the most southeast fragment found at 63.1 m from the center of the structure. This fragment weighed 502 g.

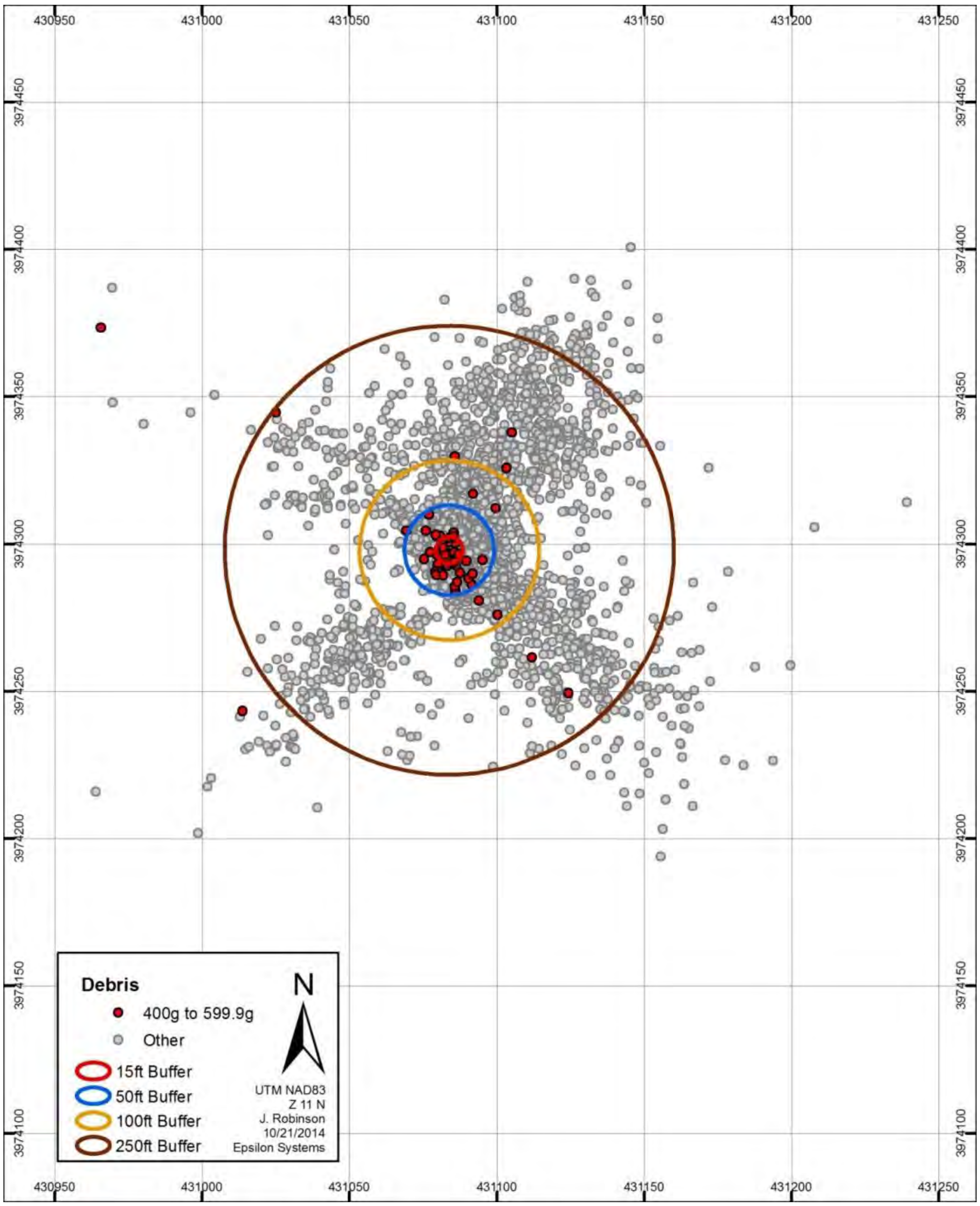

FIGURE V-G-28. Fragment Map of Fragments in the 400- to 599.9-g Range (Test 4).

Figure V-G-29 presents the fragment map for fragments weighing 300 to 399.9 g. There are 62 fragments in this range with 55 being fragments from the roof, 3 fragments from the east wall, 2 from the front (north) wall, and 2 from the rear (south) wall. The farthest fragment in the southwest direction was one from the rear wall that weighed 361.5 g and traveled 145.2 m. This fragment is shown in Figure V-G-30. A fragment from the east wall traveled 122 m and weighed 310.1 g. This fragment is shown in Figure V-G-31.

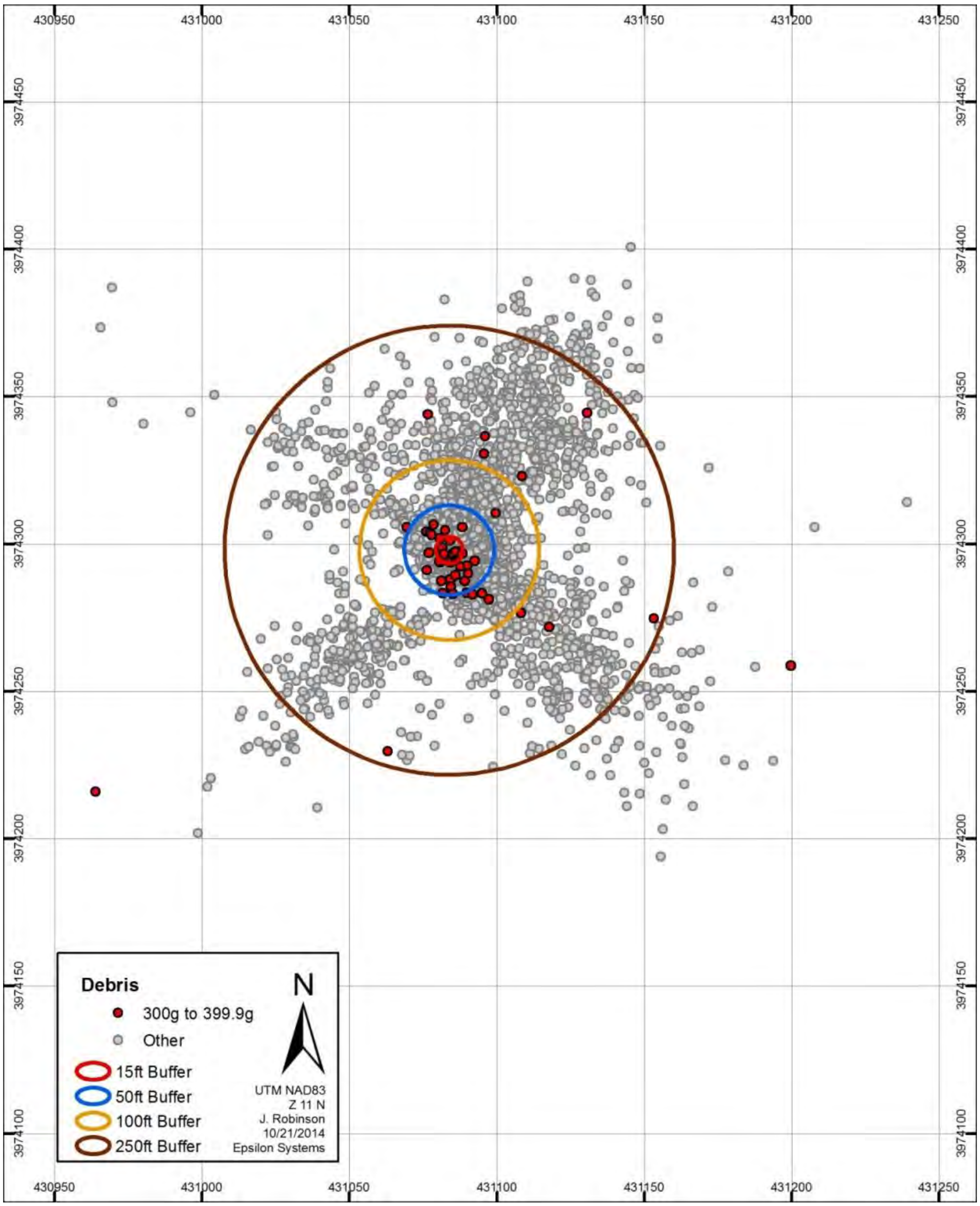

FIGURE V-G-329. Fragment Map of 300- to 399.9-g Fragments (Test 4).

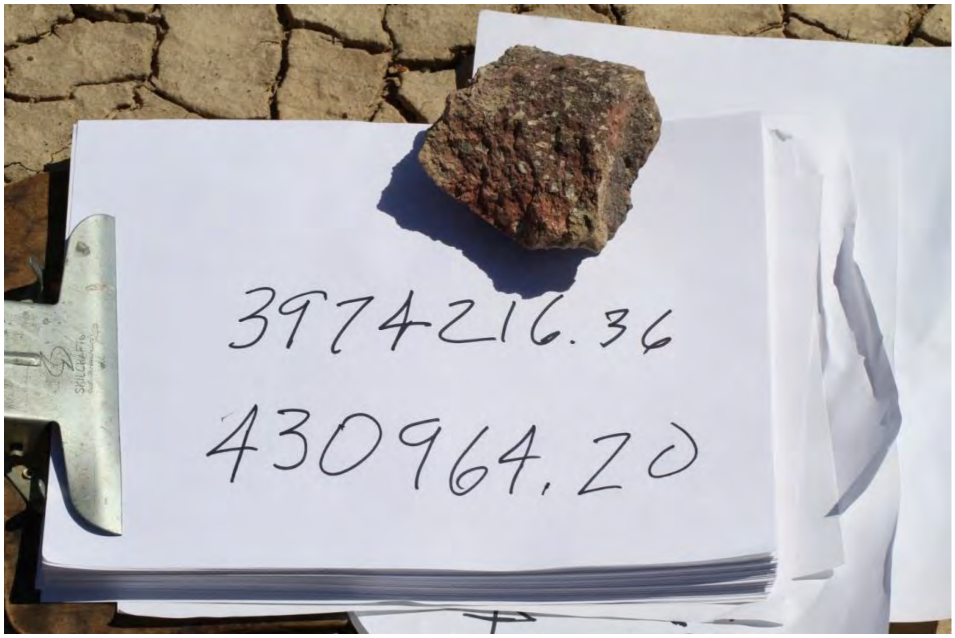

FIGURE V-G-430. Fragment From Back (South) Wall That Traveled
145.2 m and Weighed 361.5 g (Test 4).

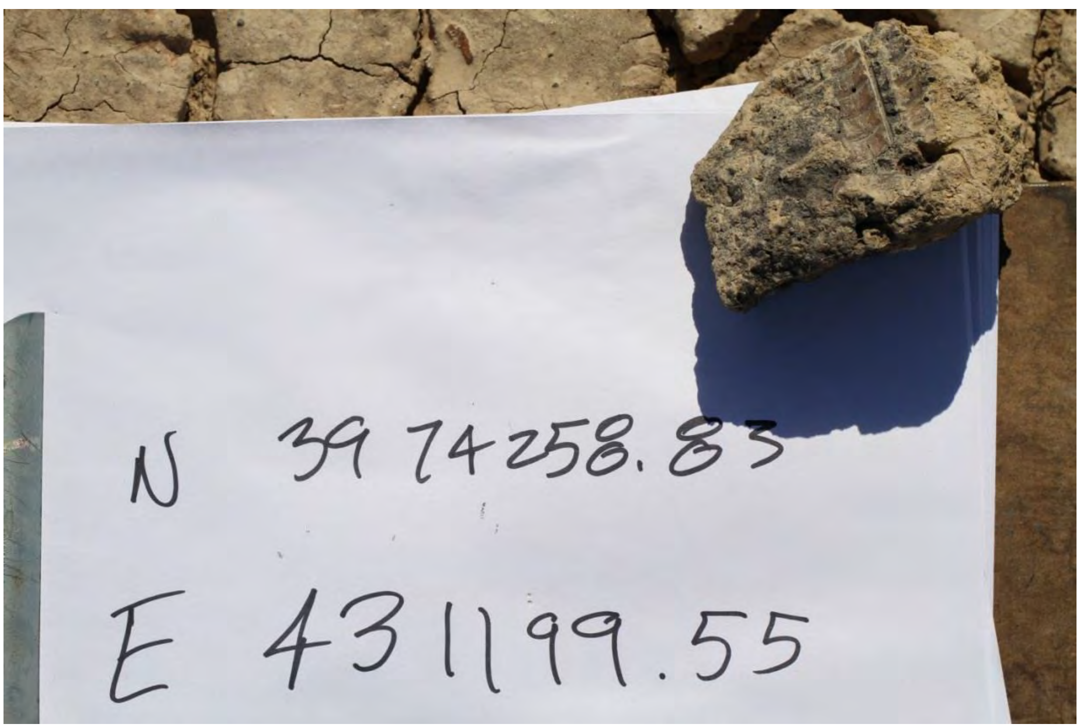

FIGURE V-G-531. Fragment From East Wall That Traveled
122 m and Weighed 310.1 g (Test 4).

Figure V-G-32 presents the fragment map for fragments in the 250- to 299.9-g range. There were 43 fragments in this range with 37 fragments from the roof, 3 from the front (north) wall, 2 from the back (south) wall, and 1 from the west wall. The two fragments from the back wall traveled the farthest in the southwest direction. The weights and distance from the center of the structure for the two fragments from the back wall were 295 g and 69.2 m, and 272.4 g and 67.5 m, respectively. The two fragments that were found at the greatest distance in the northeast direction were from the roof. The weights and distance from the center of the structure were 272.9 g and 61.9 m, and 255.3 g and 69.9 m, respectively.

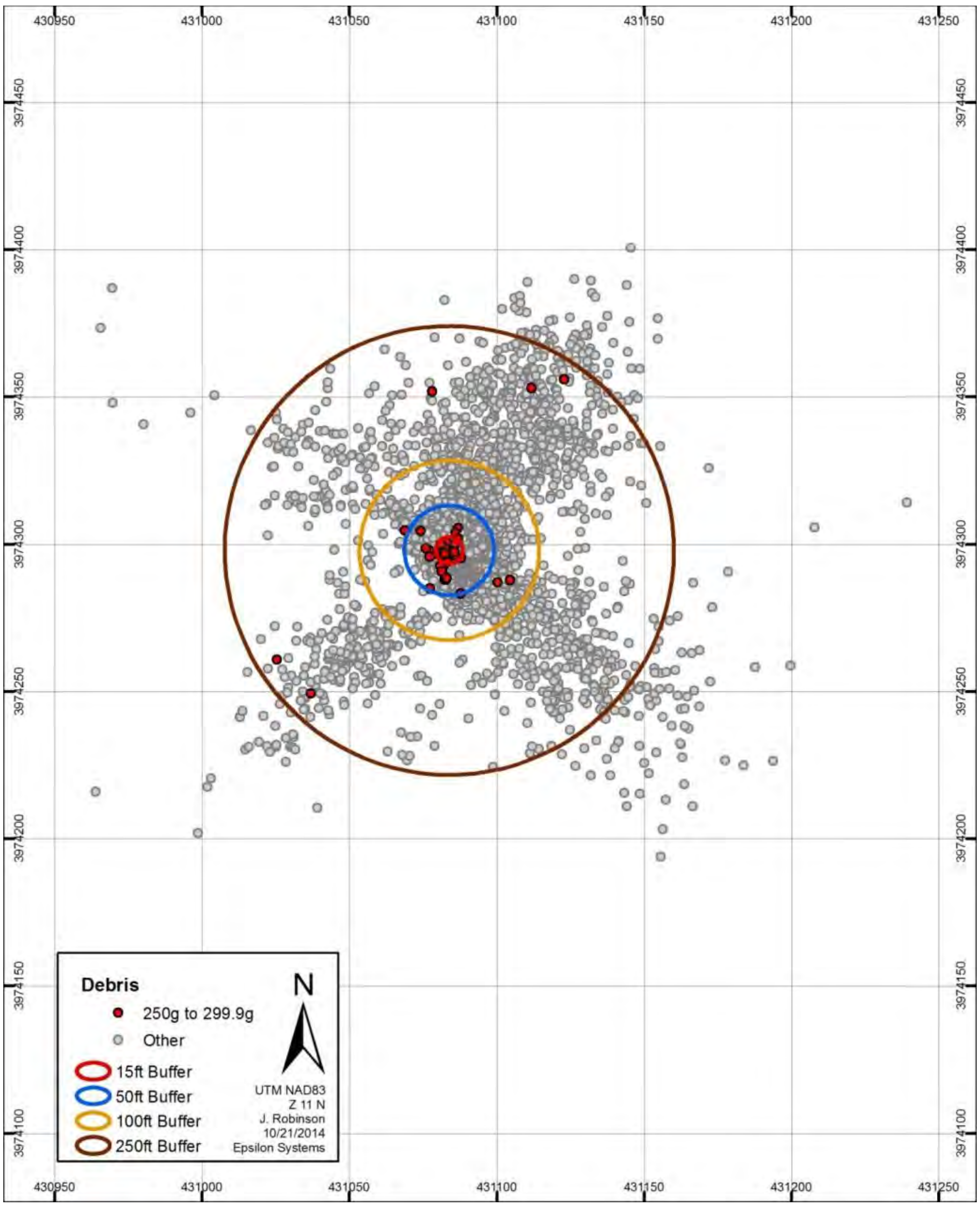

FIGURE V-G-32. Fragment Map of Fragments in the 250- to 299.9-g Range (Test 4).

Figure V-G-33 presents the fragment map of fragments in the 200- to 249.9-g range. There were 69 fragments in this range with 64 from the roof, 2 from the front (north) wall, and 1 each from the back wall, west wall, and east wall. The fragment from the back wall weighed 229.5 g and was found 69.9 m southwest from the center of the structure. The other fragment found at significant distance in the southwest quadrant supposedly (and this is subject to question) came from the front wall and weighed 200.6 g and was found 55.2 m from the center of the structure. The farthest fragment in the northwestern quadrant came from the west wall, weighed 217.6 g, and was found 51.4 m from the center of the structure. Two fragments found at distance in the northeastern quadrant were both roof fragments with one weighing 240.8 g, found 83.6 m from the center of the structure, and shown in Figure V-G-34, and the other weighing 210.5 g, found 89.5 m from the center of the structure, and shown in Figure V-G-35.

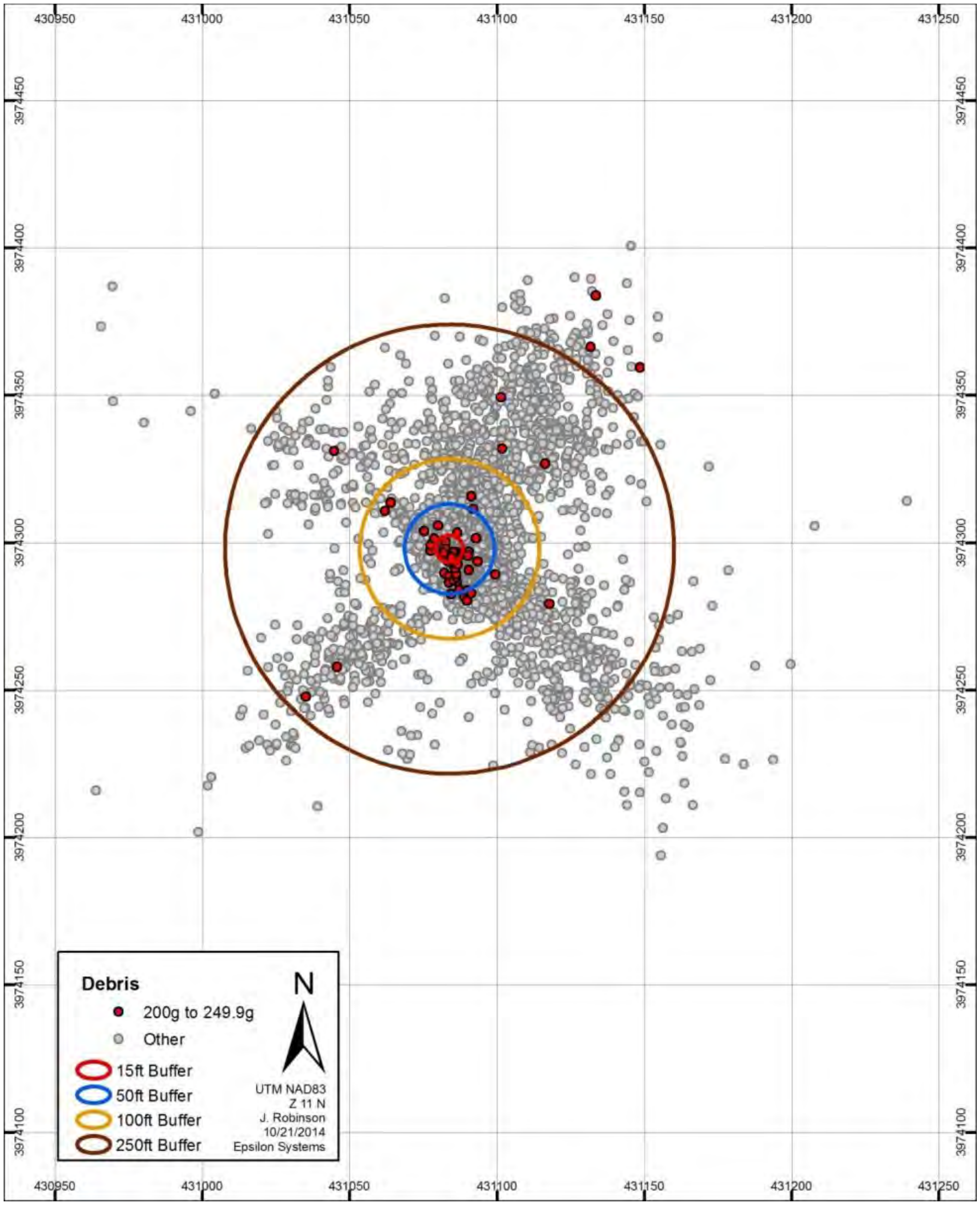

FIGURE V-G-33. Fragment Map of Fragments in the 200- to 249.9-g Range (Test 4).

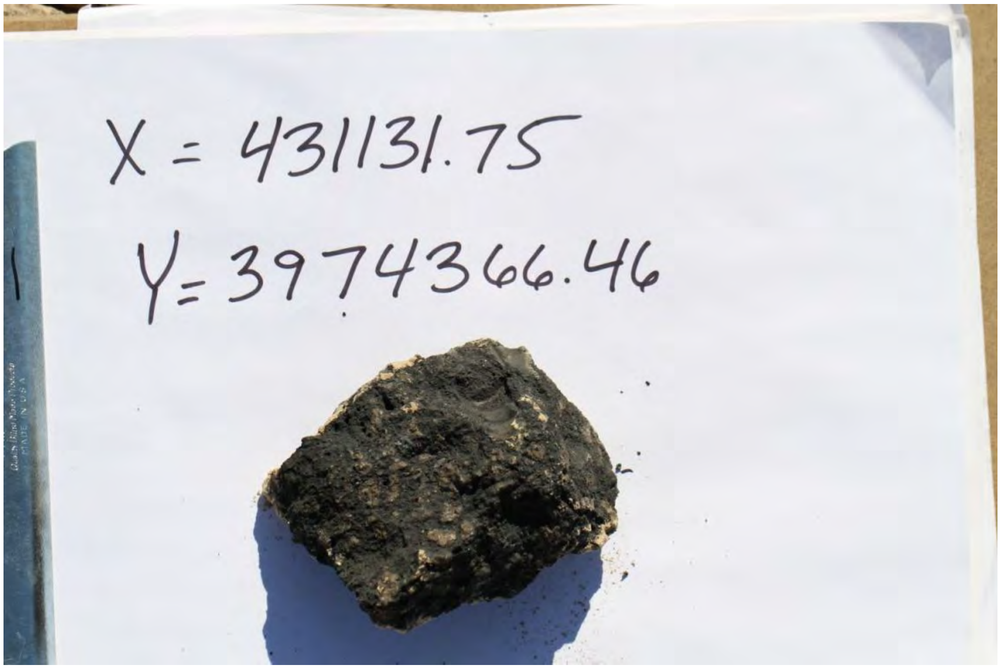

FIGURE V-G-34. Roof Fragment Weighing 240.8 g Found 83.6 m Northeast From the Center of the Structure (Test 4).

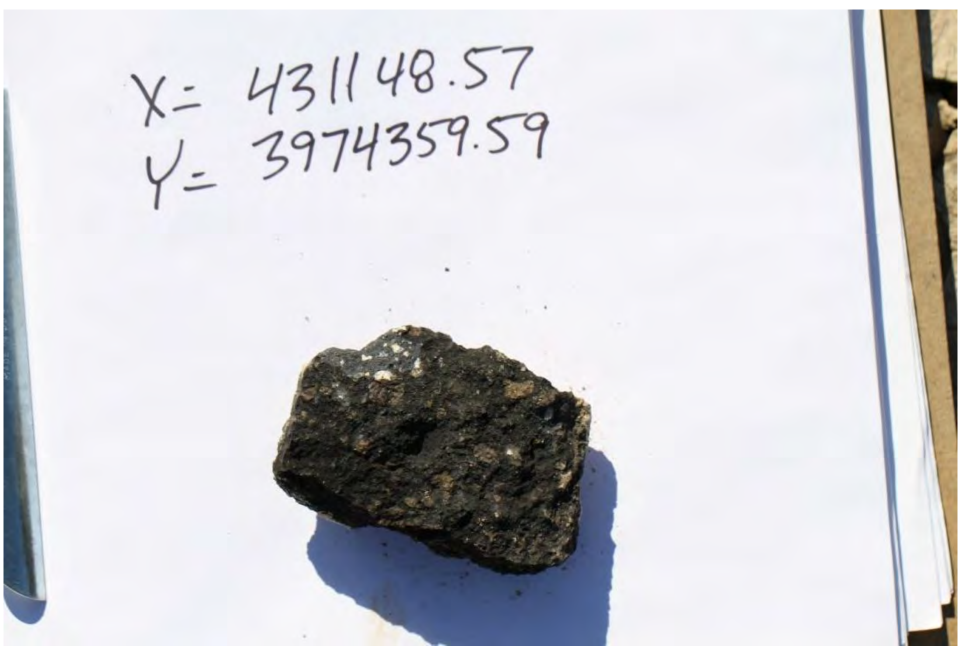

FIGURE V-G-35. Roof Fragment Weighing 210.5 g Found 89.5 m Northeast From the Center of the Structure (Test 4).

Figure V-G-36 presents the fragment map of 83 fragments in the 150- to 199.9-g range. Of the 83 fragments, 73 were from the roof, 4 were from the front (north) wall, 1 was from the back (south) wall, and 5 were from the east wall. Three fragments from the east wall were found a significant distance southeast from the structure. One fragment weighing 194.1 g was found 58.6 m from the center of the structure, one weighed 185.8 g and was found 60 m from the center of the structure, and one weighed 199 g and was found 75 m from the center of the structure. Five fragments from the roof were found approximately 60 m or further northeast from the center of the structure. The fragment weights and distances were 191.2 g at 77.8 m, 154.5 g at 77 m, 156.5 g at 62.4 m, 161.4 g at 64.9 m, and 180 g at 59.6 m. Two fragments were found a significant distance from the center of the structure in the southwest quadrant. One fragment was from the back wall weighing 165.6 g and was found 94.7 m from the center of the structure. The other fragment was supposedly from the front (north) wall weighing 171.9 g and found 85.4 m from the center of the structure.

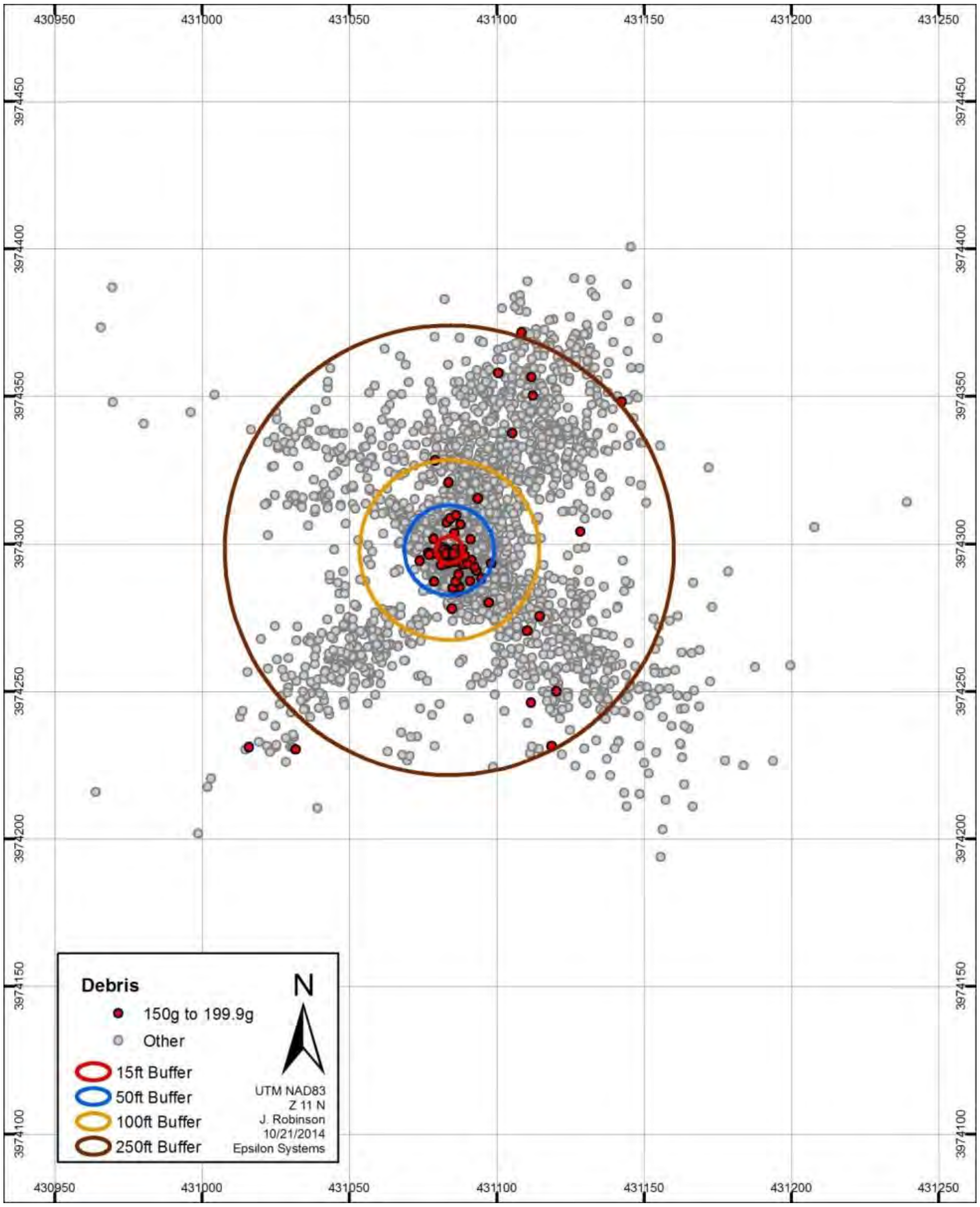

FIGURE V-G-36. Fragment Map of Fragments in the 150- to 199.9-g Range (Test 4).

Figure V-G-37 presents the fragment map for the 131 fragments in the 100- to 149.9-g range. Of the 131 fragments, 104 were from the roof, 10 were from the east wall, 8 were from the back (south) wall, 6 were from the front (north) wall, and 3 were from the west wall. The farthest fragment in the northwest quadrant was from the west wall and weighed 116 g and was found 144.9 m from the center of the structure. Other fragments found in the northwest quadrant include the following: a 138.8 g roof fragment found at 78.6 m from the center of the structure, a fragment from the front wall that weighed 102.3 g found at 68.7 m from the center of the structure, a 109.1 g fragment from the west wall found at 63.7 m from the center of the structure, and a 133.3-g fragment from the east wall found at 55.2 m from the center of the structure. The last

fragment is underlined to emphasize that this fragment was from the east wall but was found on the northwest side of the structure. There were other fragments found in areas that might be thought of as "wrong." When we came across these "anomalous" locations in the database, we double-checked to ensure they were correct as seen in the following paragraph. There were other fragments in the northwest quadrant.

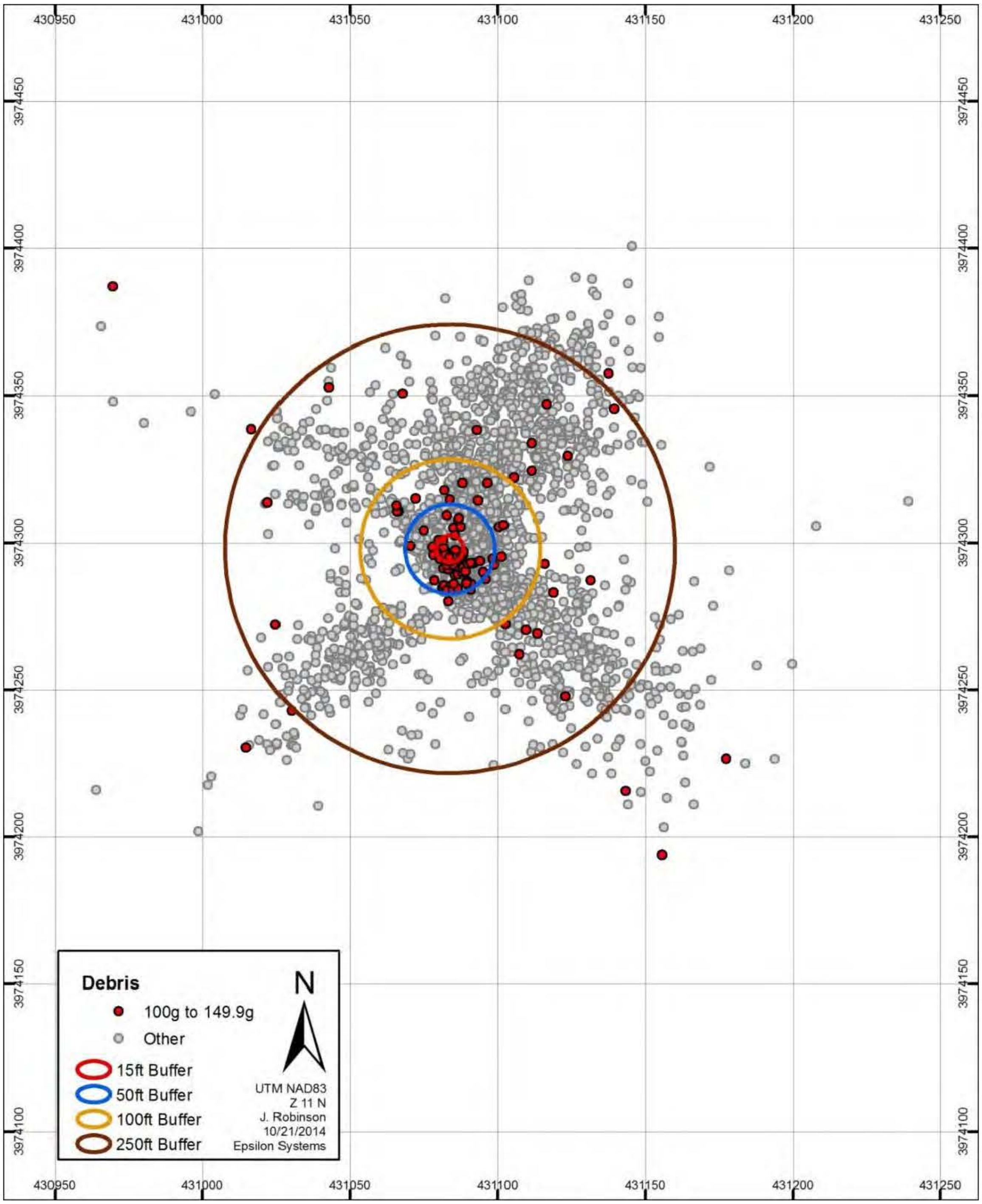

FIGURE V-G-37. Fragment Map of Fragments in the 100- to 149.9-g Range (Test 4).

The two farthest fragments in the northeast quadrant both came from the back (south) wall and are as shown in Figures V-G-38 and V-G-39. The bottom of the clip in the photograph can be used to get an indication of the size of the fragments—the bottom edge of the clip measured 6 inches (15.24 cm) across. One fragment weighed 148.8 g and was found 80.3 m from the center of the structure. This fragment is shown in Figure F-38. Also shown in the photograph are the GPS coordinates. These coordinates agree with the database entries and clearly indicate that the fragment was found in the northeast quadrant. Figure V-G-39 shows the second fragment from the back wall that was found some distance in the northeast quadrant. This fragment weighed 135.6 g and was found 73.2 m from the center of the structure. Again, the GPS coordinates match the database entry and clearly show the fragment being in the northeast quadrant.

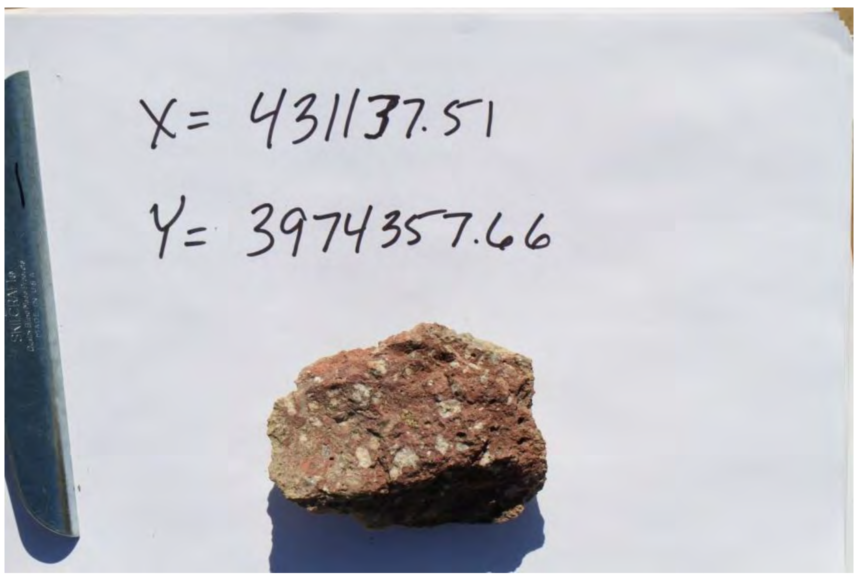

FIGURE V-G-38. Fragment From the Back (South) Wall That Was Found in the Northeast Quadrant (Test 4). The fragment weighed 148.8 g and was found 80.3 m from the center of the structure.

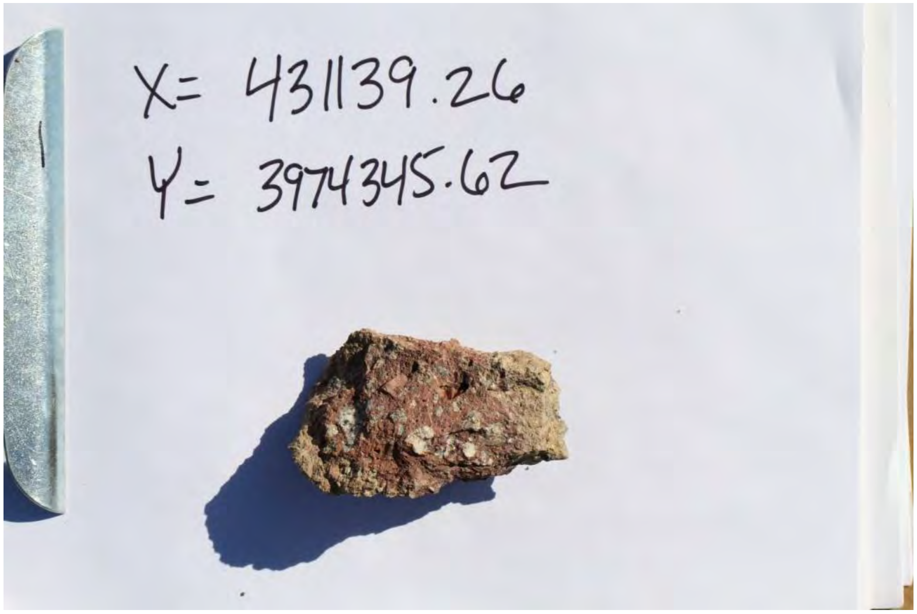

FIGURE V-G-639. Fragment From the Back (South) Wall That Was Found in the Northeast Quadrant (Test 4). The fragment weighed 135.6 g and was found 73.2 m from the center of the structure.

The three farthest fragments in the southwest quadrant are more of what might be expected. All three fragments were from the back (south) wall with weights and distance from the center of the structure indicated in the following: 100.6 g at 96.7 m, 105 g at 76.9 m, and 121.4 g at 64.4 m. The three farthest fragments in the southeast quadrant were all from the east wall with the following weights and distances: 128.2 g at 126.2 m, 143.3 g at 101 m, and 148.1 g at 117.7 m.

The three farthest fragments in the southeast quadrant are again what would be expected. All three fragments came from the east wall with the following weights and distances from the center of the structure: 128.2 g at 126.2 m (Figure V-G-40), 143.3 g at 101 m, and 148.1 g at 117.7 m (Figure V-G-41).

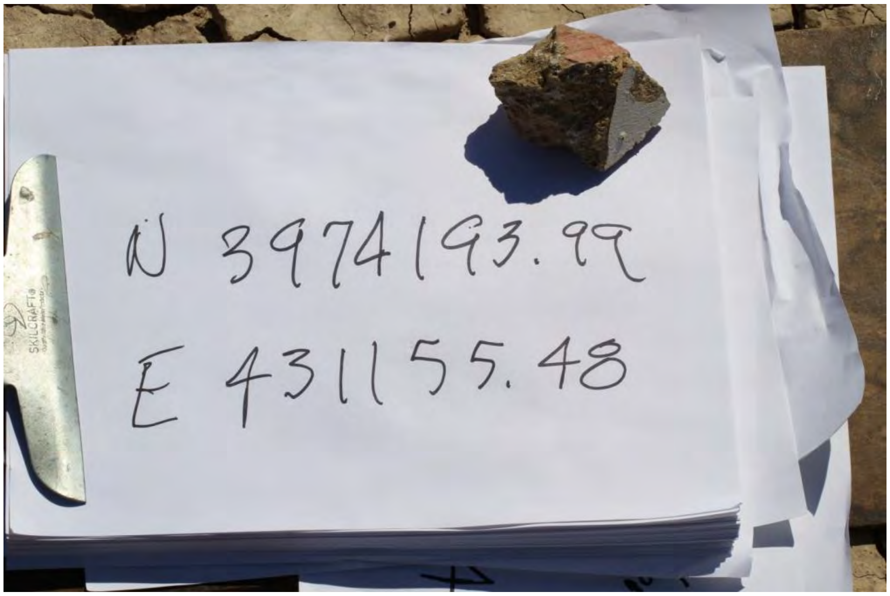

FIGURE V-G-40. Fragment From East Wall That Was Found in the Southeast Quadrant (Test 4). This fragment weighed 128.2 g and was found 126.2 m from the center of the structure.

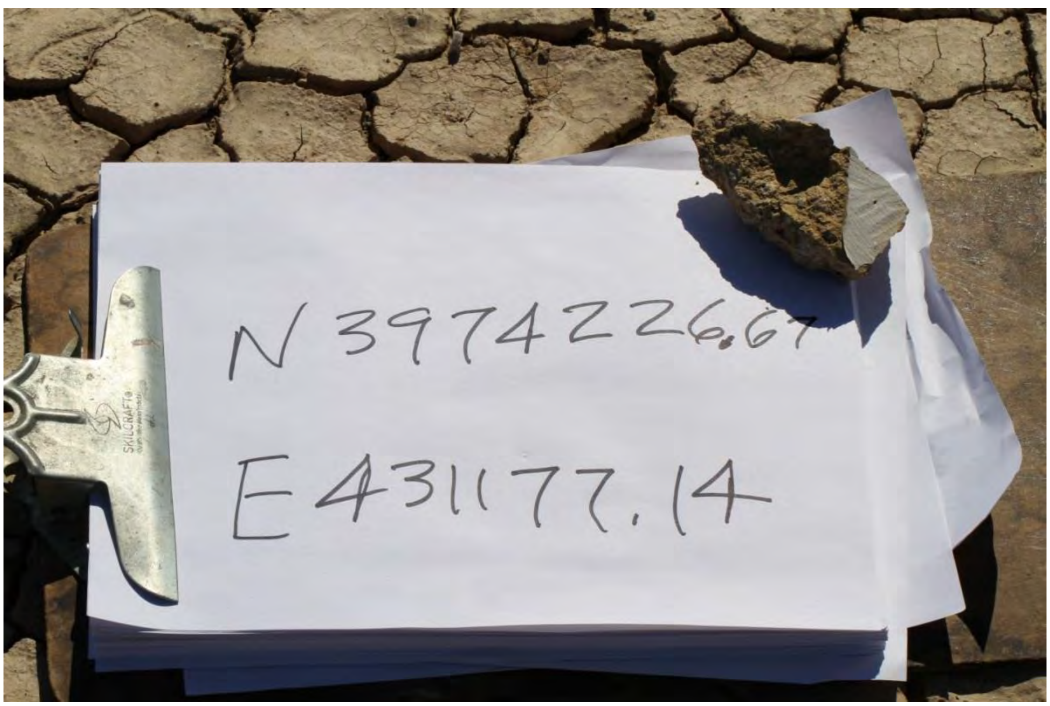

FIGURE V-G-41. Fragment From the East Wall That Was Found in Southeast Quadrant (Test 4). The fragment weighed 148.1 g and was found 117.7 m from the center of the structure.

Figure V-G-42 presents the fragment map for 102 fragments in the 80- to 99.9-g range. Of the 102 fragments, there were 85 from the roof, 5 from the front (north) wall, 6 from the east wall, 5 from the back (south) wall, and 1 from the west wall. The farthest fragments in the 80- to 99.9-g range are presented in Table V-G-3.

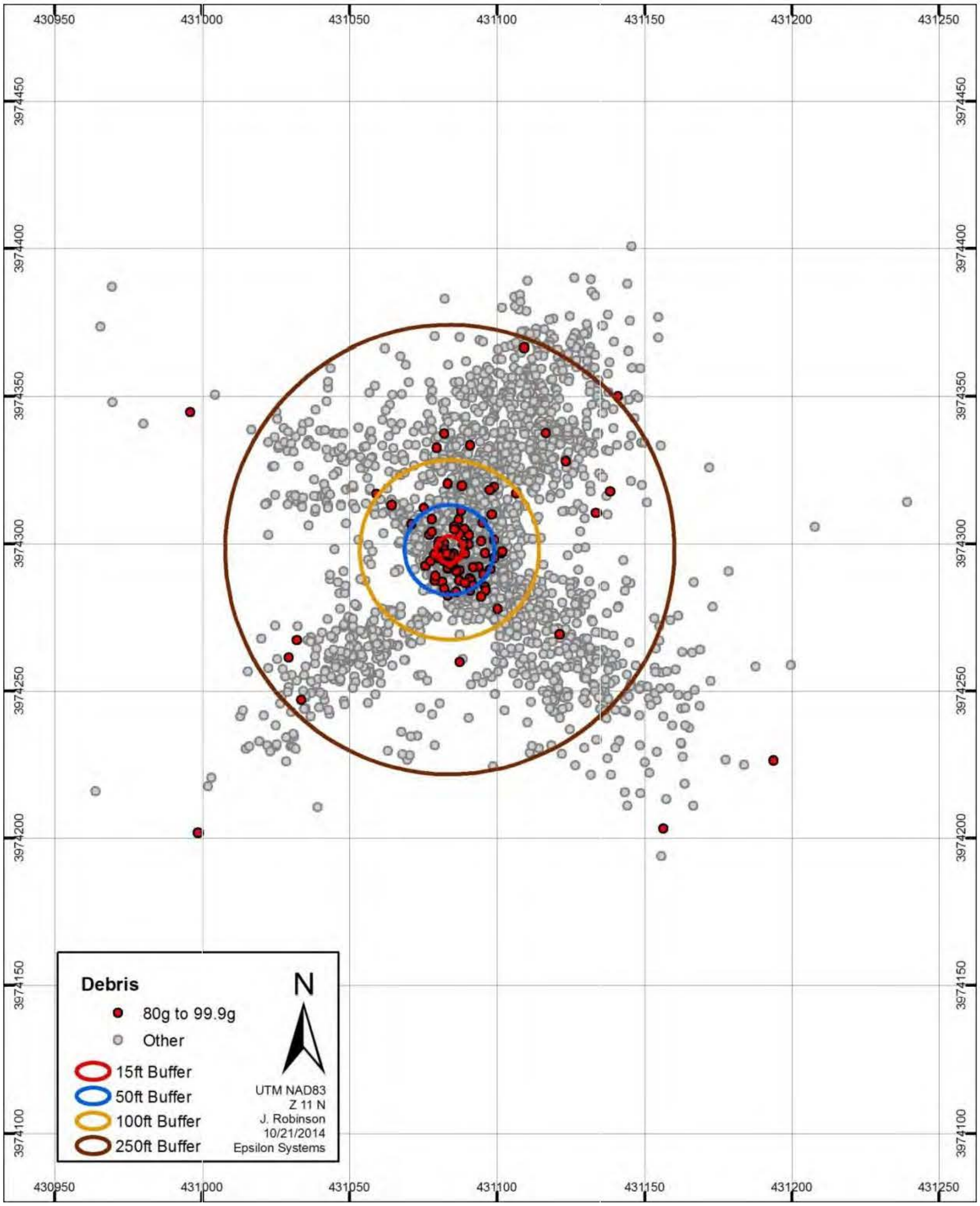

FIGURE V-G-42. Fragment Map of Fragments in the 80- to 99.9-g Range (Test 4).

TABLE V-G-3. Farthest Fragments in the 80- to 99.9-g Range (Test 4).

Quadrant	Weight, g	Origin	Distance From Center of Structure, m
North-west	85.0	West wall	99.3
South-west	86.7	Back (south) wall	124.7
South-east	96.6	East wall	119.2
South-east	82.0	East wall	131.2
North-east	93.3	Roof	77.2

Figure V-G-43 presents the fragment map for 121 fragments in the 60- to 79.9-g range, with 84 from the roof, 6 from the front (north) wall, 13 from the east wall, 12 from the back (south) wall, 4 from the west wall, and 2 pieces of rebar. The farthest fragments in this 60- to 79.9-g range are given in Table V-G-4. Once again, a fragment from the back (south) wall was found in the northeast quadrant.

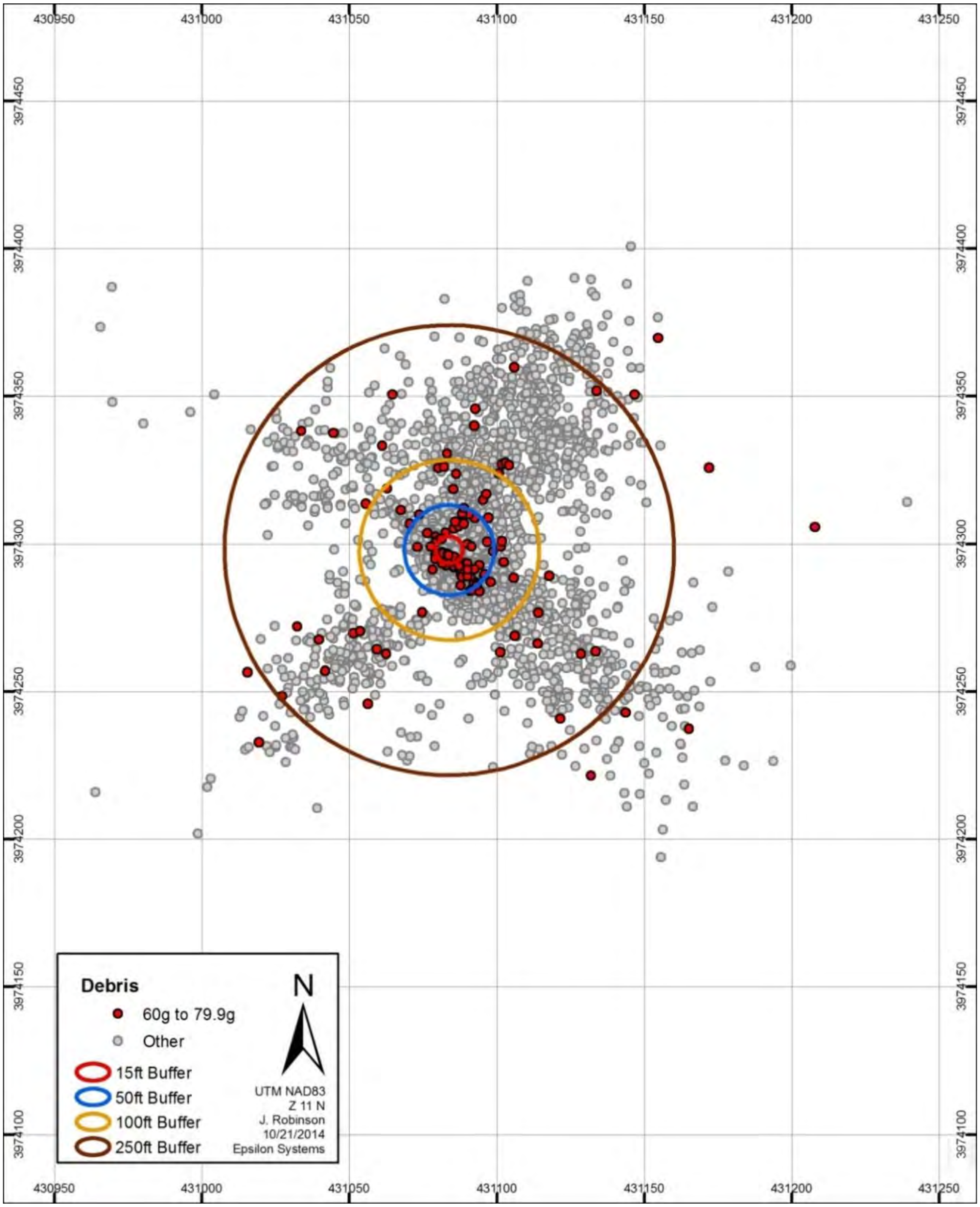

FIGURE V-G-43. Fragment Map of Fragments in the 60- to 79.9-g Range (Test 4).

TABLE V-G-4. Farthest Fragments in the 60- to 79.9-g Range (Test 4).

Quadrant	Weight, g	Origin	Distance From Center of Structure, m
Southwest	78.4	Back (south) wall	91.5
Southwest	60.8	Back wall	79.9
Southwest	76.0	Back wall	75.3
Southeast	77.0	East wall	90.1
Southeast	60.2	East wall	108.6
Northeast	63.0	Roof	124.1
Northeast	74.1	Back wall	92.3
Northeast	73.5	Roof	100.8

Figure V-G-44 presents the fragment map for the 203 fragments in the 40- to 59.9-g range. Of the fragments, 150 were from the roof, 7 from the front wall, 30 from the east wall, 9 from the rear (south) wall, 6 from the west wall, and 1 piece of rebar. Table V-G-5 presents data for the farthest fragments in the 40- to 59.9-g range for each quadrant.

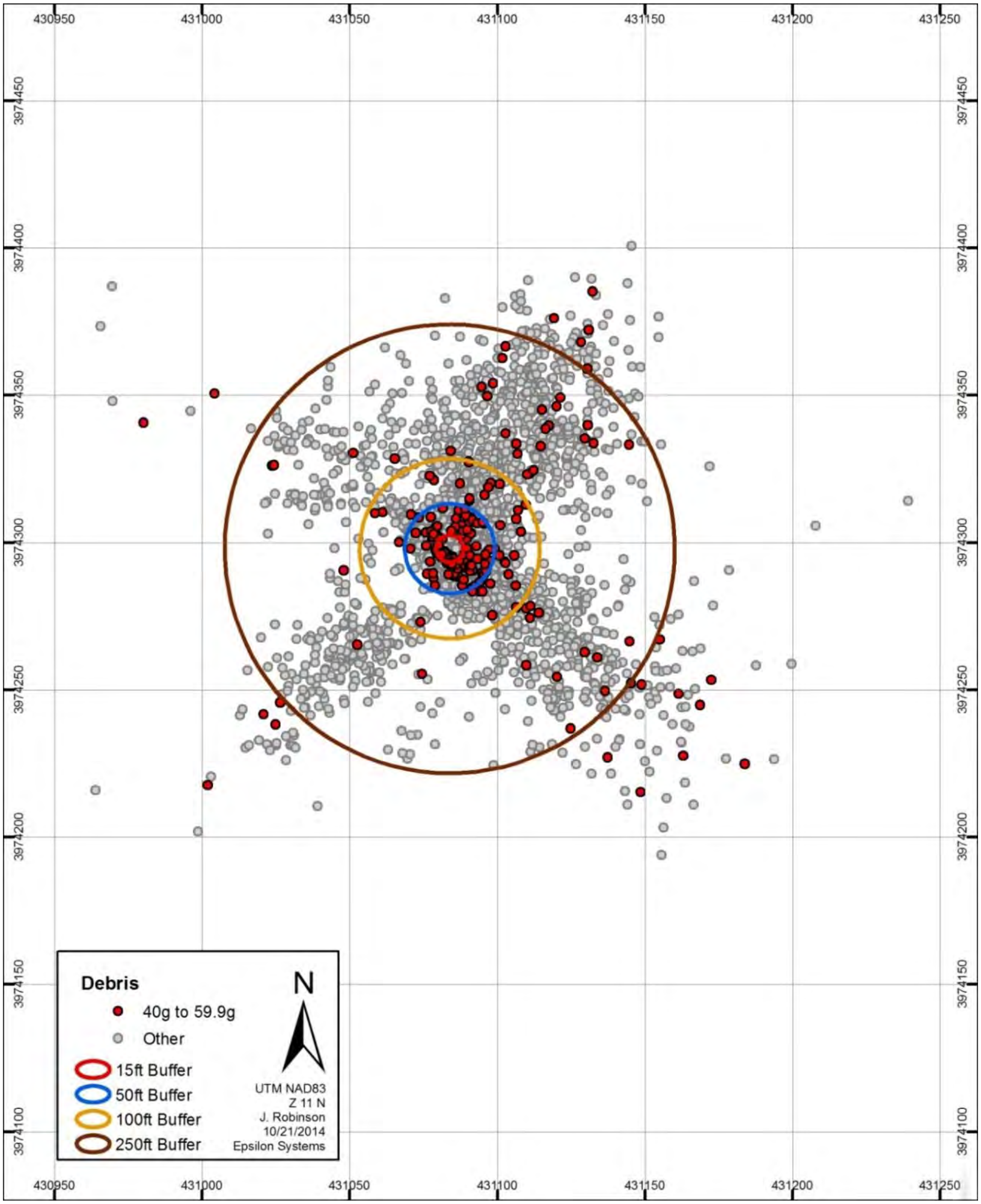

FIGURE V-G-44. Fragment Map of the 40- to 59.9-g Fragments (Test 4).

TABLE V-G-5. Farthest Fragments in the 40- to 59.9-g Range (Test 4).

Quadrant	Weight, g	Origin	Distance From Center of Structure, m
North-west	54.9	Roof	112.0
North-west	49.0	West wall	57.8
South-west	48.8	Back (south) wall	114.7
South-west	54.0	Back wall	83.8
South-west	46.2	Back wall	77.5
South-west	42.6	Back wall	84.4
South-east	57.8	East wall	105.0
South-east	55.4	East wall	105.8
South-east	54.1	East wall	123.7
North-east	54.4	Roof	76.8
North-east	57.9	Roof	83.2
North-east	46.6	Roof	87.8
North-east	45.4	Roof	85.9

Figure V-G-45 presents the fragment map for the 276 fragments in the 25- to 39.9-g range. Of the 276 fragments, there were 195 from the roof, 9 from the front (north) wall, 51 from the east wall, 17 from the back (south) wall, 3 from the west wall, and 1 large paint chip. Table V-G-6 presents the weights and distance from the center of the structure for some of the fragments having the greatest throw distances for the 25- to 39.9-g fragments.

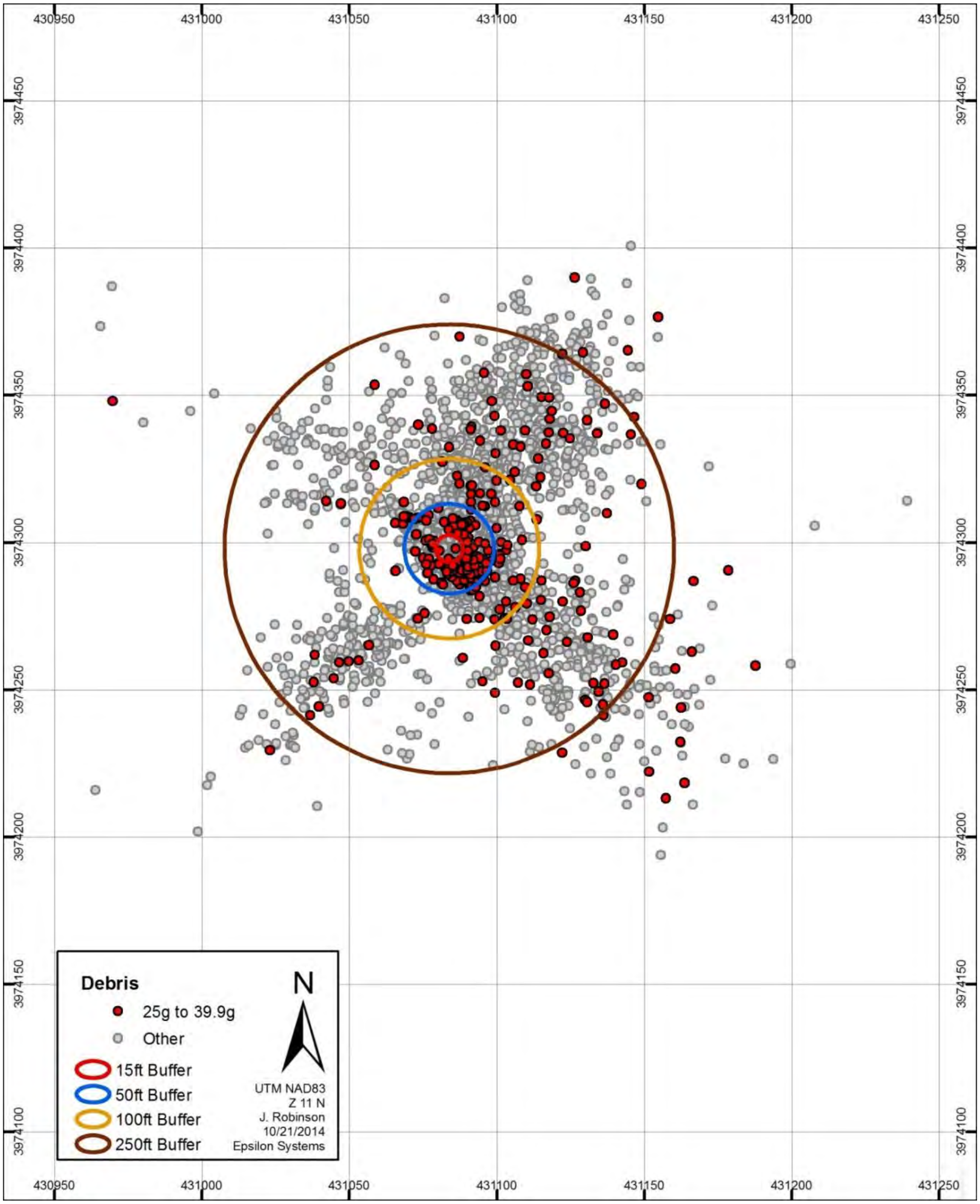

FIGURE V-G-45. Fragment Map of the 25- to 39.9-g Range (Test 4).

TABLE V-G-6. Farthest Fragments in the 25- to 39.9-g Range (Test 4).

Quadrant	Weight, g	Origin	Distance From Center of Structure, m
North-west	36.5	West wall	124.6
South-west	27.7	Back (south) wall	91.6
South-east	30.0	East wall	112.6
South-east	27.7	East wall	112.1
South-east	26.3	East wall	101.6
South-east	29.1	East wall	111.2
North-east	38.1	Roof	105.9
North-east	37.3	Roof	101.4

Figure V-G-46 presents the fragment map for the 383 fragments in the 15- to 24.9-g range. Of the 383 fragments, 239 were from the roof, 16 from the front (north) wall, 78 from the east wall, 36 from the back (south) wall, 13 from the west wall, and 1 piece of rebar. Table V-G-7 presents the data for fragments found the farthest from the center of the structure for the 15- to 24.9-g range.

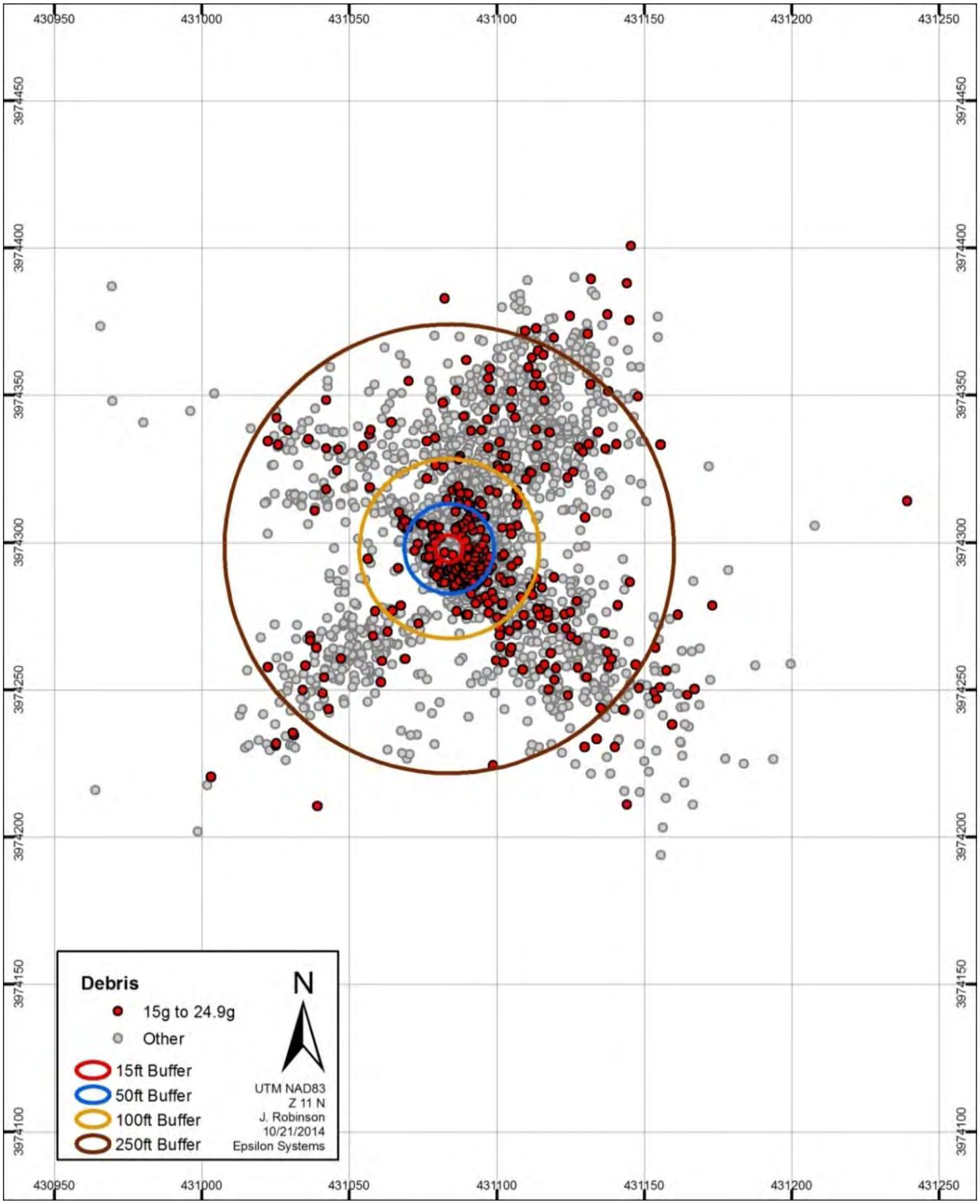

FIGURE V-G-46. Fragment Map of the 15- to 24.9-g Range (Test 4).

TABLE V-G-7. Farthest Fragments in the 15- to 24.9-g Range (Test 4).

Quadrant	Weight, g	Origin	Distance From Center of Structure, m
South-west	19.3	Back (south) wall	111.9
South-west	18.6	Back wall	98.1
South-east	20.4	East wall	105.7
North-east	23.7	Front (north) wall	156.1
North-east	15.4	Roof	119.8
North-east	18.9	Roof	103.4
North-east	19.2	Roof	108.5
North	17.0	Roof	84.9

Figure V-G-47 presents the fragment map for the 1,269 fragments weighing 5 g to less than 14.9 g. Of the 1,269 fragments in this range, 876 were from the roof, 57 from the front (north) wall, 159 from the east wall, 130 from the rear (south) wall, 46 from the west wall, and 1 from the corner of the back and west wall. Some of the fragments found the farthest distance from the center of the structure are listed in Table V-G-8.

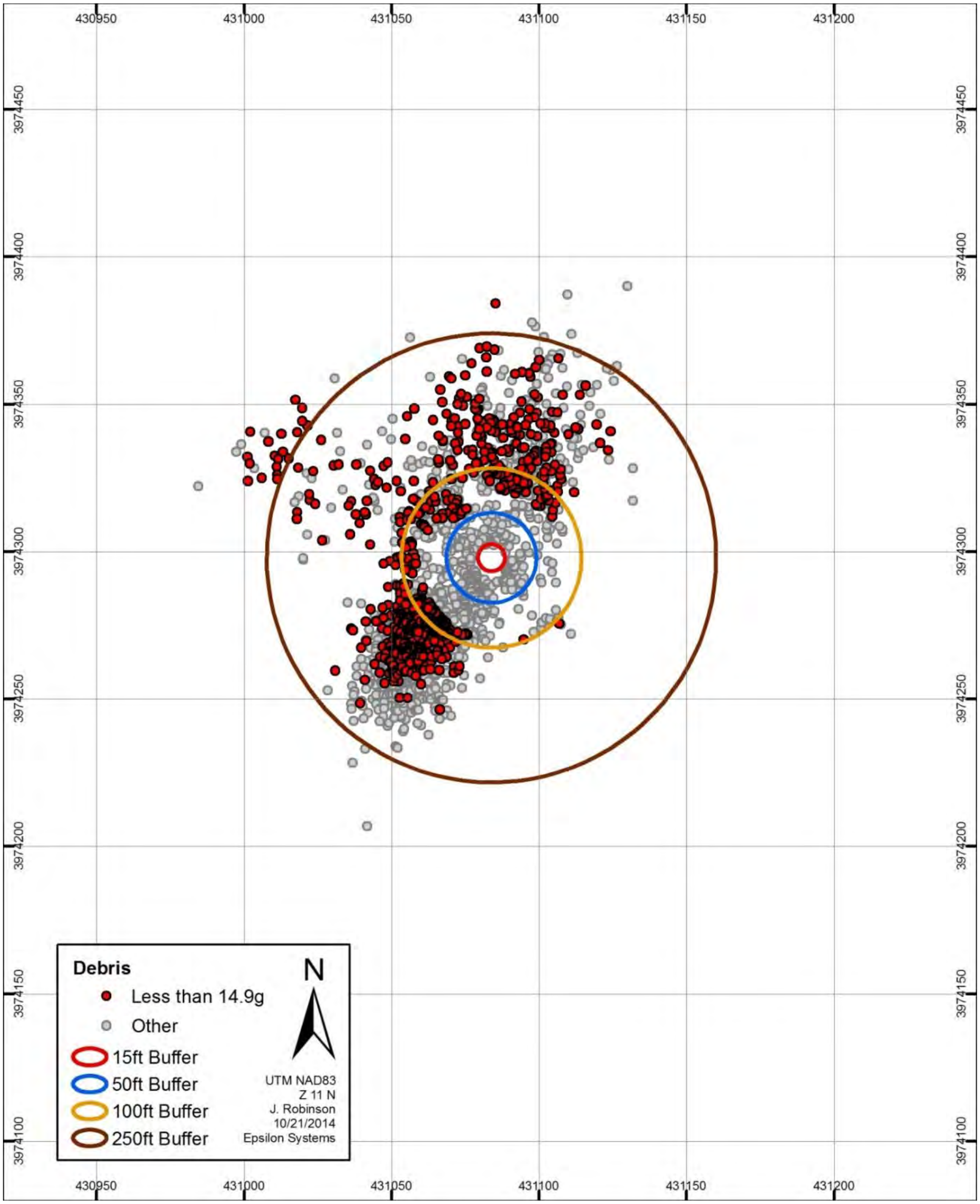

FIGURE V-G-47. Fragment Map for Debris Weighing Less Than 14.9 g (Test 4).

TABLE V-G-8. Farthest Fragments in the 5- to 14.9-g Range (Test 4).

Quadrant	Weight, g	Origin	Distance From Center of Structure, m
North	6.3	Roof	94.8
North-west	9.1	West wall	70.4
South-west	6.4	Back (south) wall	90.8
South-west	6.7	Back wall	90.7
South-east	7.7	East wall	120.0
South-east	14.7	East wall	100.1
South-east	12.6	East wall	102.3

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CHAPTER VI. MODELING OF HD1.3 HAZARDS TESTING

EXECUTIVE SUMMARY

This chapter provides an overview of the modeling work completed at the Naval Air Warfare Center Weapons Division (NAWCWD) China Lake, Naval Facilities Engineering Command Engineering and Expeditionary Warfare Center (NAVFAC EXWC) at Port Hueneme, APT Research Inc., and ACTA Inc. The chapter is divided into two areas. The first section focuses on developing a predictive component to assess and understand the M1 propellant burning in a reinforced concrete structure and how it causes the structure to respond; the data from Tests 1 through 4 in the series provided the basis. This section concludes with an analysis of how the current siting criterion inadequately predicts the fragmentation of the structure as a result of the material being HD1.3. The second section addresses what types of testing in the future may lead to increased reaction violence as indicated by farther fragments or increased structural breakup. This section examines the effect of loading density inside the structure and the amount of burning surface area available.

BACKGROUND

The National Aeronautics and Space Administration (NASA) funded a study to reexamine the explosive siting for the Kennedy Space Center Vehicle Assembly Building (VAB). This study concluded in 2011 and was a highly analytical study examining the ability to increase the explosive limits of the facility to enable the storage of multiple Orion systems. Focusing on HD1.3 rocket motors, the outcome of this study showed that the VAB would allow for an increase in HD1.3 material since the facility's walls failed at relatively low pressure, thus preventing pressurization of the structure. The most significant hazard was the exhaust plumes and thermal flux produced by the burning propellant (References VI-1 and VI-2).

The Department of Defense Explosive Safety Board (DDESB) leveraged what was learned from this study and funded an effort to examine its potential application to the Department of Defense (DOD). The first part of this effort examined the accidents that have occurred with explosives in the past 100 years and their cause. As mentioned previously, this document illustrated that the majority of accidents started with a fire (Reference VI-3). The second part of the effort examined the types of ordnance that DOD had in its inventory. This document indicated that the majority of items in the

Navy inventory were HD1.4 materials. These items are typically small and have low explosive weight. Hazard Division 1.1 materials made up the most explosive weight. In general, it was most likely that magazines would contain HD1.1, 1.2, 1.3, and 1.4 materials (Reference VI-4). Hazard Division 1.3 and 1.4 material is easier to thermally ignite versus HD1.1. As more munitions become insensitive munitions (IM) compliant, it is anticipated that the amount that fall into HD1.1 will diminish. Therefore, the potential for a thermal event will increase as the amount of HD1.1 decreases (Reference VI-5). Finally, the third part of this effort was a modeling study that examined the effect of a HD1.3 material burning inside a structure and how the pressurization differed if the material burned versus detonated. When detonated, the material produced a rapid pressurization versus when the material burned (pressure was produced at a much slower rate for a longer amount of time). The difference in pressurization rate would cause a significant difference in the structural response. The pressurization rate inside the structure was dependent on the material loading density of the structure and the burning surface area (Reference VI-6). The conclusions from DDESB efforts generated the question, "Can our current models predict the structural response and hazard profile of an incident containing HD1.3 materials?" An attempt is being made to couple the experimental tests and the current models to begin to answer that question.

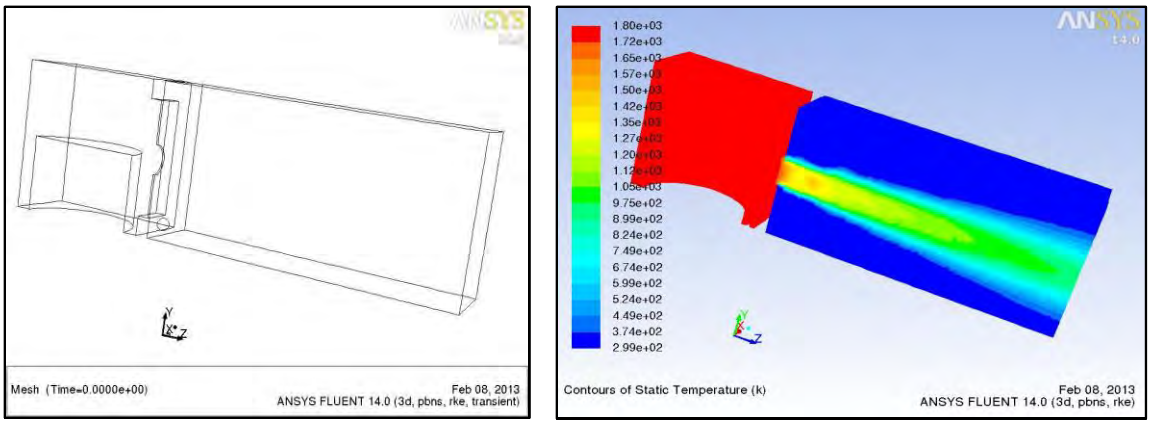
ANALYSIS

Modeling efforts were performed to understand the thermal behavior of the propellant and how the pressurization of the structure affects how the Kasun structure failed. High-fidelity, physic-based analysis software was used to explore both the propellant behavior and the structural behavior. These models were then used to predict the response of the structure for future testing. Current siting tools found in TP-14 and DoD 6055.09 were also used to compare the current siting criteria to the fragment pattern found in Tests 2 and 4. Fast running models were also explored that could be used in the future to improve the siting criteria and to determine debris throw and thermal hazards.

THERMAL

The Combustion Sciences Branch of NAWCWD used the ANSYS Fluent Computational Fluid Dynamics (CFD) models developed for Reference VI-6 and adapted them for the Kasun structure using M1 gun propellant. The previous models developed used M10 gun propellant so they were modified for M1 burning behavior. The M1 burning rate used was derived from an assessment of both reported literature values and closed bomb measurements. The mesh used in the simulation can be seen in Figure VI-1a, where the propellant is the cylinder in the image and air is internal and external to the structure. The models allowed for the calculation of pressurization for Tests 2 and 4 along with the plume extending out the front of the structure. In the

models, the maximum temperature calculated in the plume was slightly above 1500°C. This was consistent with temperature above 1250°C being measured when the propellant burned in the test. Figure VI-1b shows the formation of the plume outside the structure. A steady-state condition was achieved where the exiting mass flow rate was calculated at 13.35 kg per second to achieve an internal pressure of 46.4 psi in the simulation. This compares to the 46.54 psi measured in Test 2.



(a) CFD Mesh. (b) Plume Formation.

FIGURE VI-1. ANSYS Fluent Simulations.

STRUCTURAL

The Naval Facilities Engineering Command Engineering and Expeditionary Warfare Center modeled the structural response of the Kasun structure in LS-DYNA. Reference VI-7 provides details of the study, which includes the mesh parameters, concrete and rebar properties, and a sensitivity analysis. The Kasun structure was modeled according to the drawings; deviation from drawing design on how the door was tied in was made based on post-test pictures following rupture of the structure from Tests 2 and 4. The pressure-time histories from Tests 2 and 4 were used to apply the load to the walls of the structure. Ten different simulations were run. The first six simulations used the pressure-time history from Test 2. In Run 1, the lap splices were modeled explicitly. The results of the model can be found in Figure VI-2. Figure VI-2a shows the initial failure of the structure at 0.865 seconds with Figure VI-2b modeling the complete failure of the roof. The simulation captured many of the failure mechanisms of Test 2 but overpredicted the damage to the structure specifically at the walls and the joints, as seen in Figure VI-3 (Reference VI-7).

(a) 0.865 second.

(b) 1.126 second.

FIGURE VI-2. Run 1 Damage Contours.

FIGURE VI-3. Test 2 Structure Post Test.

A number of parameters were varied to try to achieve closer damage levels to the structure: applying the load non-uniformly, changing the coefficient of friction between the bottom of the floor slab and the slide condition, changing how the lap splices were modeled, and varying the concrete strength. A reduction in the load to the walls versus the roof and floor slab was modeled to reduce the damage at the joints. This case had less damage to the walls, but the floor still separated from the walls. There was also no indication of the structure rotating in the models (as observed in Test 2). The changes in the coefficient of friction between the bottom floor slab and the ground support (the structure was on wood pallets during testing) did not significantly affect the results. Changing the rebar so that the nodes of lapped bars were coincident and merged seemed to produce the most effect. This portrayed the rebar as fused together at the lap splices, representing an upper bound for the strength of the structure. Figure VI-4 depicts the results of the simulation. As seen in the figure, the walls do not separate from the floor and the door blows out, similar to Test 2. However, the damage to the roof is less than seen in the test. The concrete strength was varied due to the uncertainty of the concrete strength at the day of test. The strength of the concrete did not significantly change the response of the structure and could not reproduce the results of Test 2 (Reference IV-7).

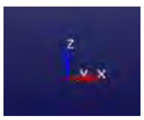
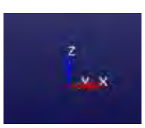


FIGURE VI-4. Run 5 Damage Contours at 0.94 Second.

Simulations were also performed using the pressurization rate found in Test 4. These simulations were unable to duplicate the damage level found in Test 4. Unlike the previous runs using a Test 2 pressurization rate, none of the simulations could replicate the amount of damage observed in Test 4. The lap splices of the rebar were modeled with a gap between the beam elements, and the load was transferred through the layer of concrete elements; previously, this produced a greater damage level using the Test 2 pressurization rate. However, as seen in Figure VI-5a, the structure did not fail in the same manner as during Test 4. The lap splices were also modeled so that the rebar was fuzed together at the lap splice (repeat of run 5, Figure VI-5b), also using the Test 4 pressurization; as seen in the test, it did not fail (Reference IV-7).

(a) At 1.59 second Run 7.



(b) At 1.59 second Run 9.

FIGURE VI-5. Damage Contours.

Further analysis was not performed using the simulations due to the inability to repeat the response of the structure. Launch velocities based on the material models could be used to calculate the trajectory of the debris to determine the debris distribution. In future tests, it is required to more accurately document the material strength of the

concrete and rebar, the rebar details, and the loading and construction procedures of the structure so that a more accurate model of the structure can be used (Reference IV-7).

EXPLOSIVE SITING COMPARISON

APT-Research compared the quantity-distance and risk-based siting methodology for HD1.3 with the results found in Tests 2 and 4. Details of the analysis can be found in Appendix VI-A. This analysis shows the limitations of using the currently employed siting criteria to predict the response of the HD1.3 in a reinforced concrete structure. In addition, APT-Research also compared the HD1.3 testing to those of a similar structure with HD1.1 explosive.

Tests 2 and 4 fragmentation results were compared to the results obtained by using the DDESB approved siting tools (Explosive Safety Siting [ESS] and Safety Assessment for Explosive Risk [SAFER]) (References VI-8 and VI-9). A Kasun type structure was constructed in the programs. The two tests were then modeled strictly as a HD1.3 event, HD1.1 event, and a modified HD1.1 event based on TNT equivalency. The results of the ESS analysis as a HD1.3 event can be found in Table VI-1. The inhabited building distance (IBD) and the public traffic route distance (PTRD) was approximately 75 feet and the intermagazine distance (IMD) and intraline distance (ILD) was predicted to be 50 feet for all four tests with a HD1.3 material with the tested NEW. Note that the models default to a minimum IBD/ PTRD of 75 feet if the calculation is below the 75-foot distance. As can be seen in Figures VI-6 and VI-7, the structure produced fragments beyond the predicted distance where it would have been acceptable to place a public building or public highway. Test 2 and Test 4 conditions were also inputted into SAFER. In the risk-based approach, HD1.3 has primarily a thermal hazard. For conditions of Tests 2 and 4 with HD1.3 in a concrete structure, the fireball radius was calculated to be 35.2 feet (Test 2) and 34.6 feet (Test 4). These conditions used over 1,000 pounds of HD1.3 material. The plume produced from Tests 1 and 3 extended beyond 35 feet, with less than 300 pounds of material in an unchoked condition. Both ESS and SAFER models need to be improved to adequately predict the thermal and fragmentation hazard from HD1.3 explosives.

TABLE VI-1. Quantity Distance Arcs as Calculated by ESS Software for HD1.3.

Test	Facility #	NEW, lb	Type	IBD, ft	PTRD, ft	ILD, ft	IMD, ft
Test 1	Cube 1	296	HD1.3	75	75	50	50
Test 2	Cube 2	1,176	HD1.3	76	75	50	50
Test 3	Cube 3	264	HD1.3	75	75	50	50
Test 4	Cube 4	1,108	HD1.3	75	75	50	50

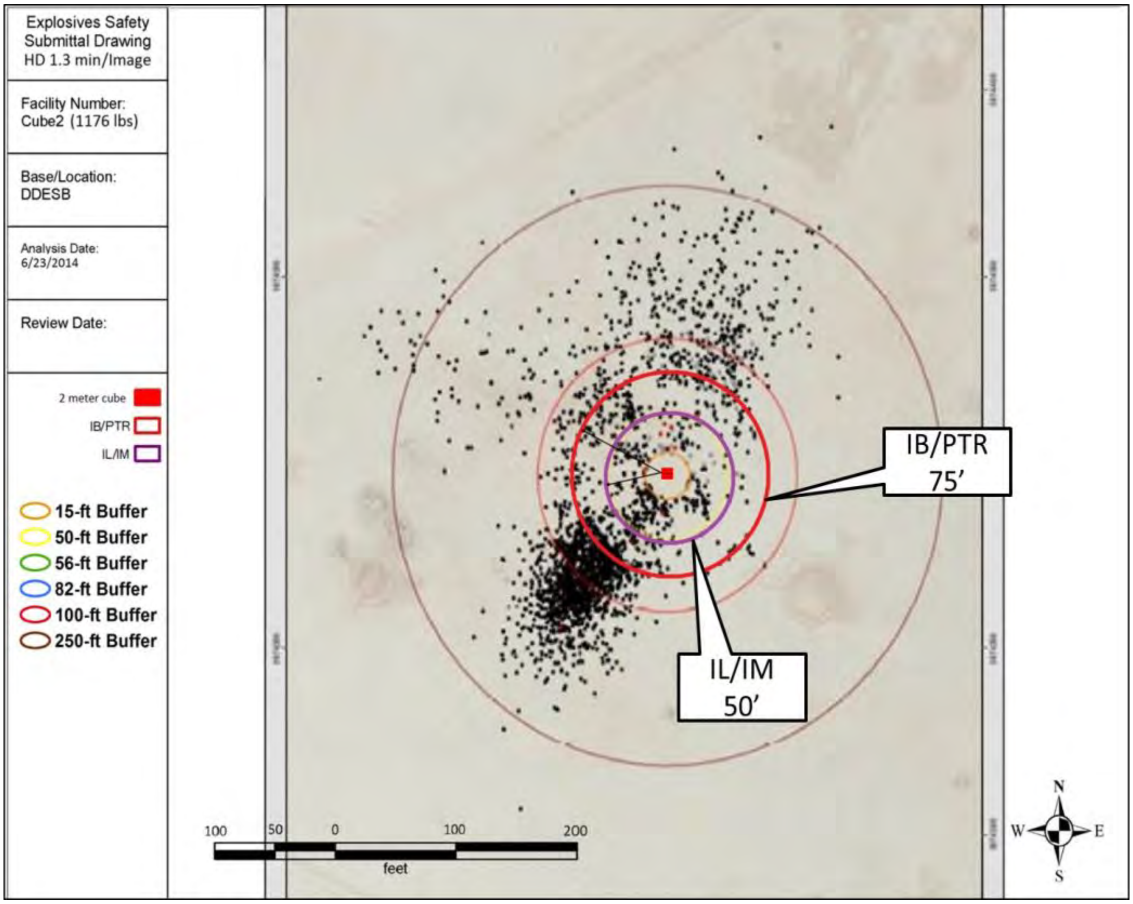


FIGURE VI-6. ESS Estimation for HD1.3 Event From Test 2.

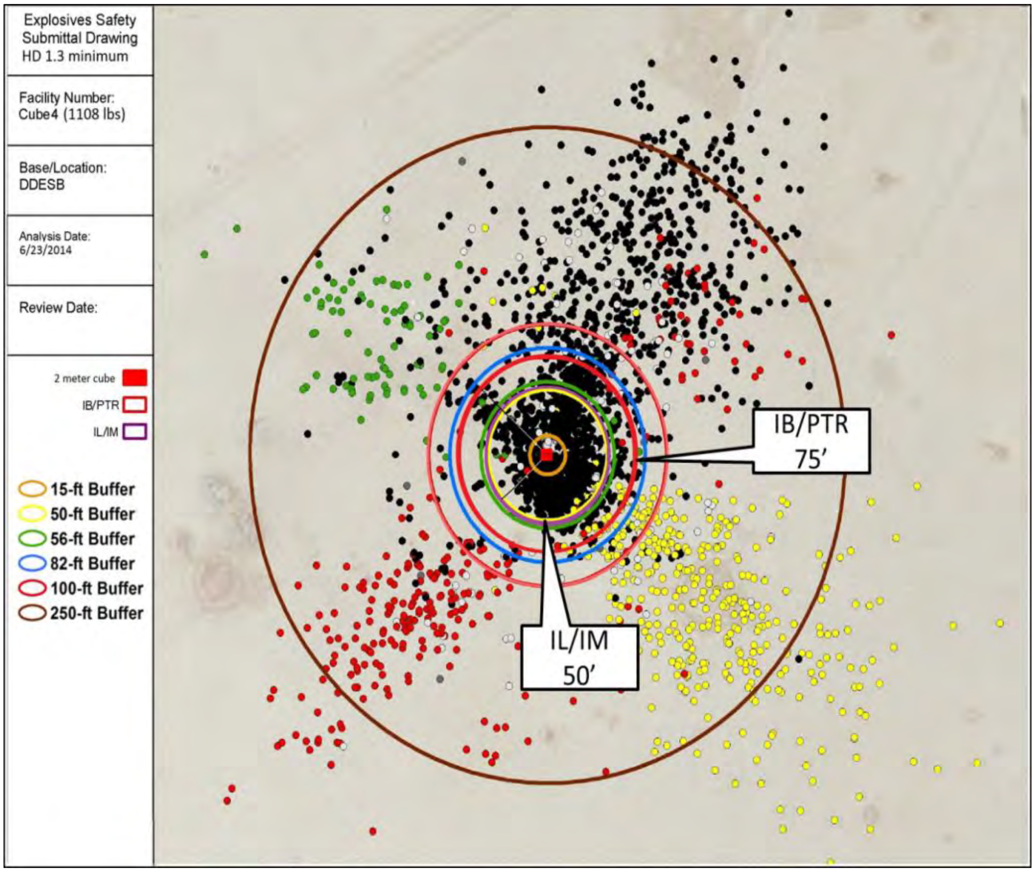


FIGURE VI-7. ESS Estimation for HD1.3 Event From Test 4.

Tests 2 and 4 were also modeled as HD1.1 or an HD1.1 with a TNT equivalency of 0.85. Both of these conditions over predicted the response of the structure. Figure VI-8 shows the prediction for Test 4 when it is modeled as an HD1.1 explosive versus the HD1.3. It can be seen that the predicted distances (IBD 1,250 feet) would be ultraconservative when compared to the actual response (farthest fragment found 508 feet). In addition, when modeled as a modified HD1.1 explosive with a TNT equivalency of 0.85 (Figure VI-9), it predicts the IBD to be 392 feet; the fidelity of this model could be refined to be more accurate. SAFER was also used to compare the risk based approach. The predicted pressure, impulse, and debris density for both conditions was much greater than those measured for Tests 2 and 4.

Further analysis was performed by APT-Research to compare the fragmentation results found in Tests 2 and 4 to the Kasun test results that were performed in Sweden on HD1.1 bare and cased charges. Figure VI-10 displays the mass distribution from Tests 2 and 4 by the appropriate bin; the larger the fragments the smaller the bin number. When the results of Tests 2 and 4 are compared to the HD1.1 results from Sweden, it can be seen that the HD1.3 results produce larger fragments (Figure VI-11). Further analysis is required to assess if a method exists to more accurately predict the fragmentation pattern based on TNT equivalency and/or percentage of NEW.

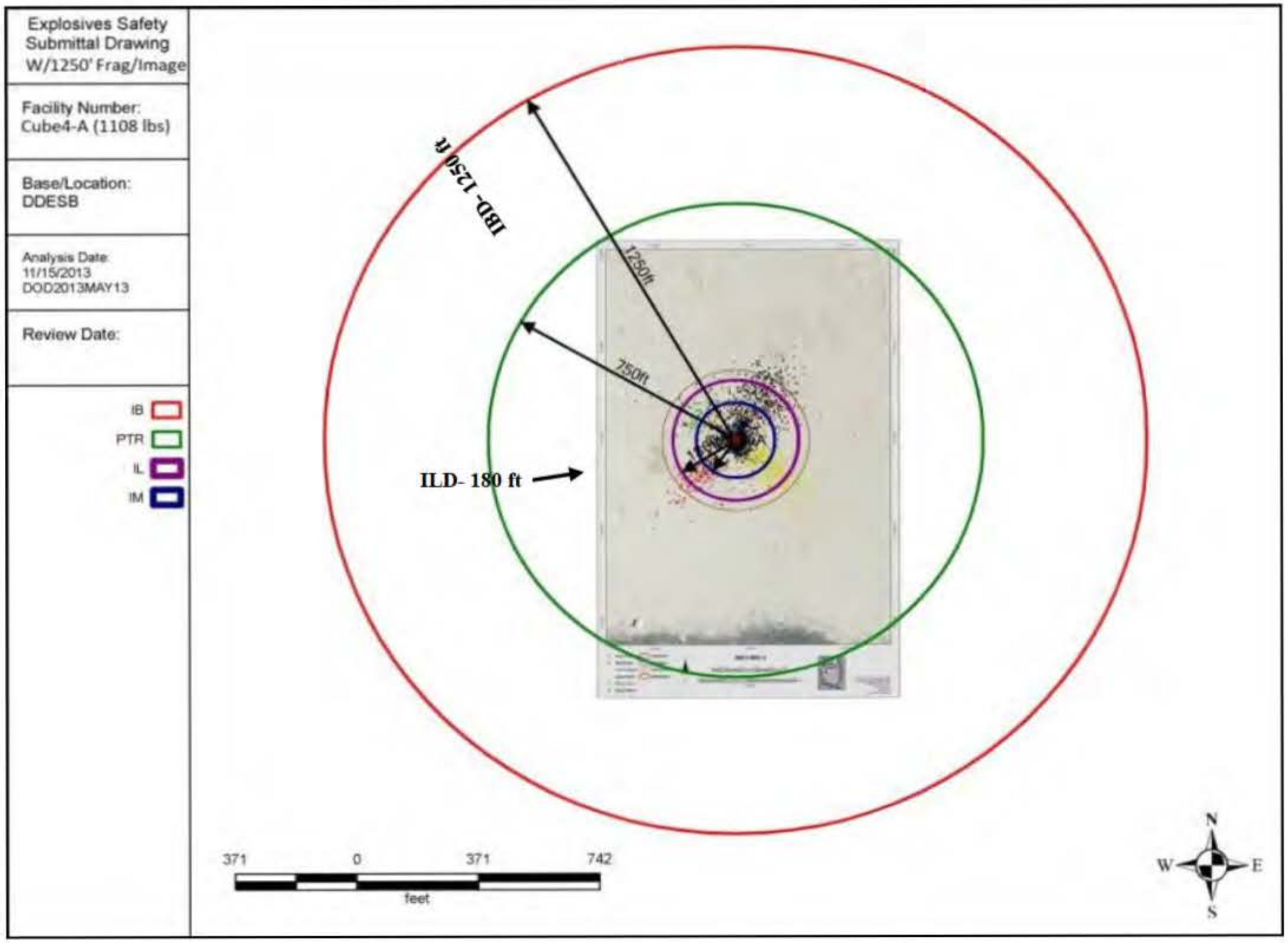


FIGURE VI-8. ESS Prediction of Test 4 as an HD1.1 Explosive.

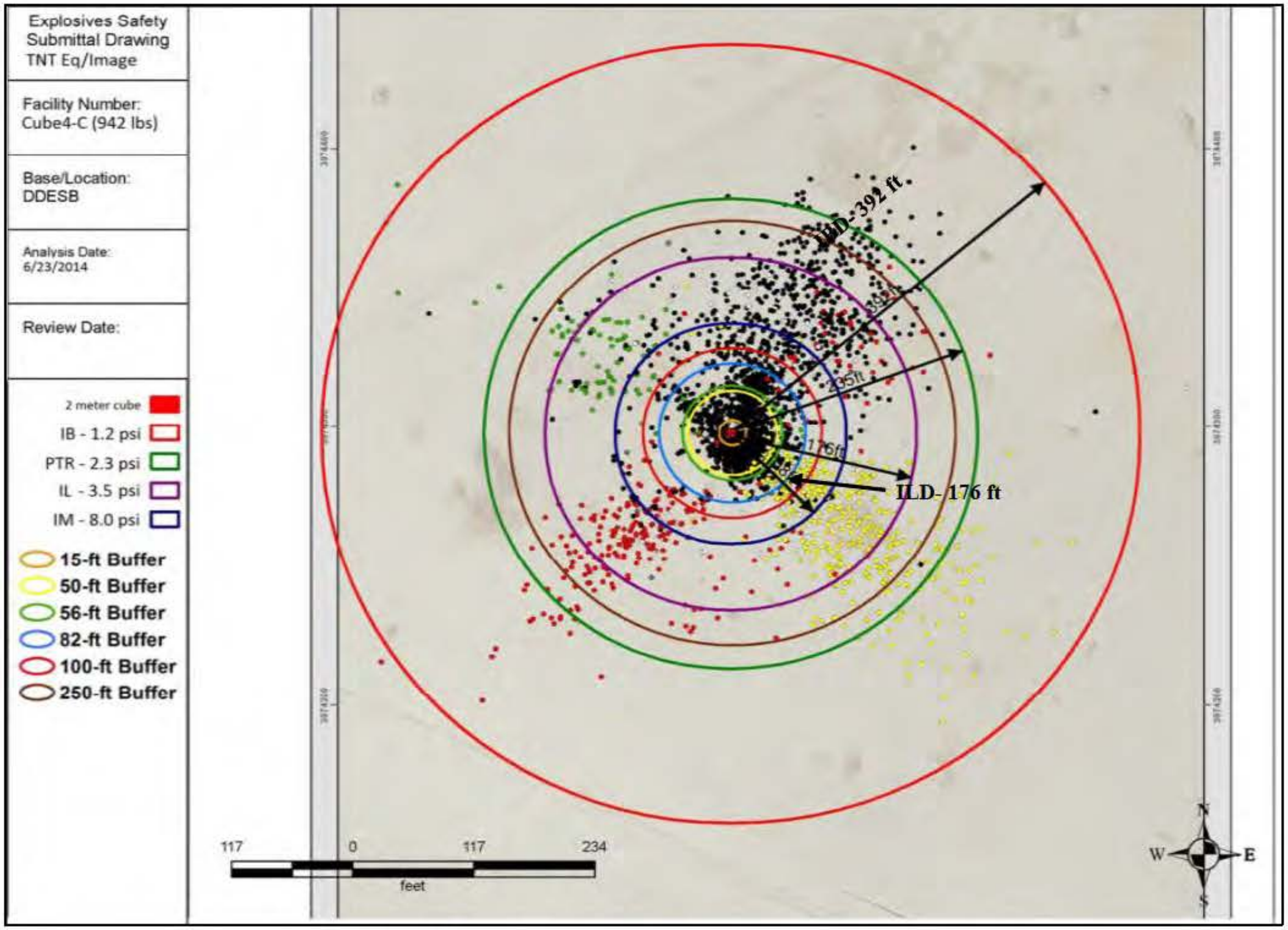
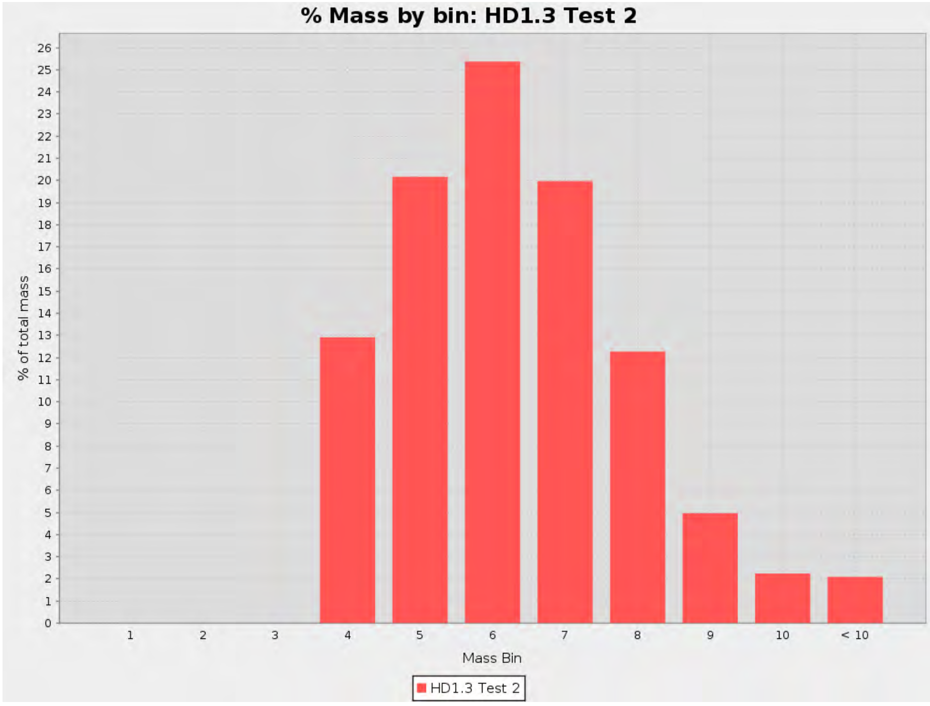
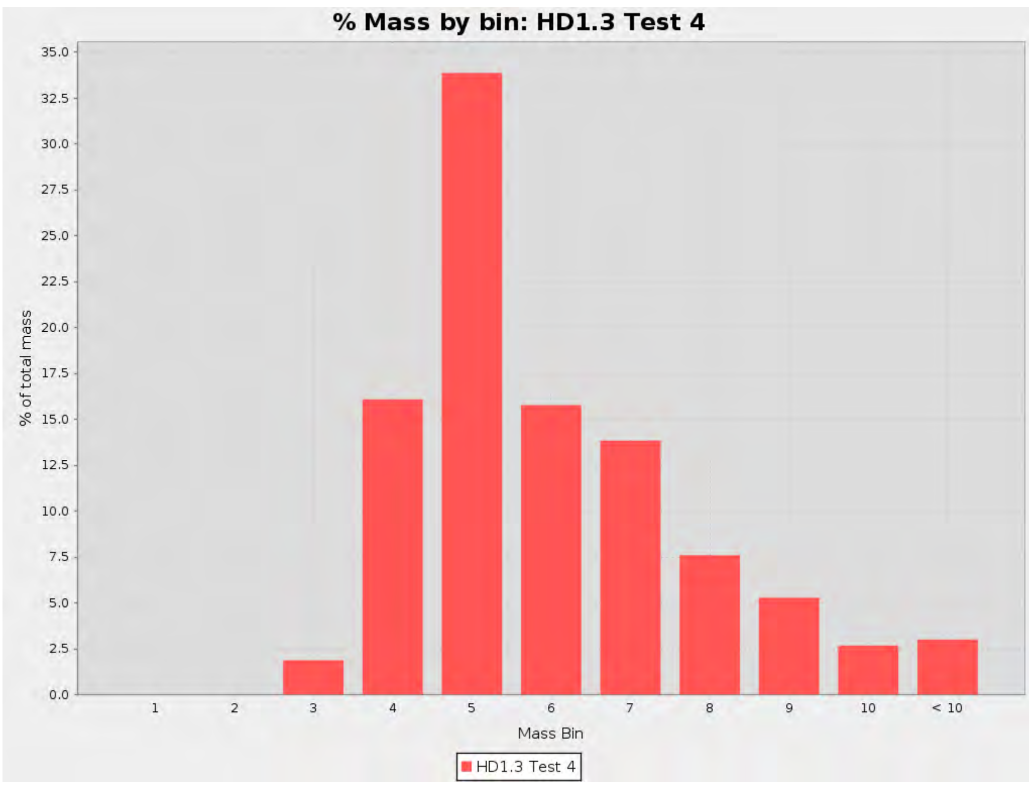


FIGURE VI-9. ESS Prediction of Test 4 as an HD1.1
Explosive With TNT Equivalency of 0.85.

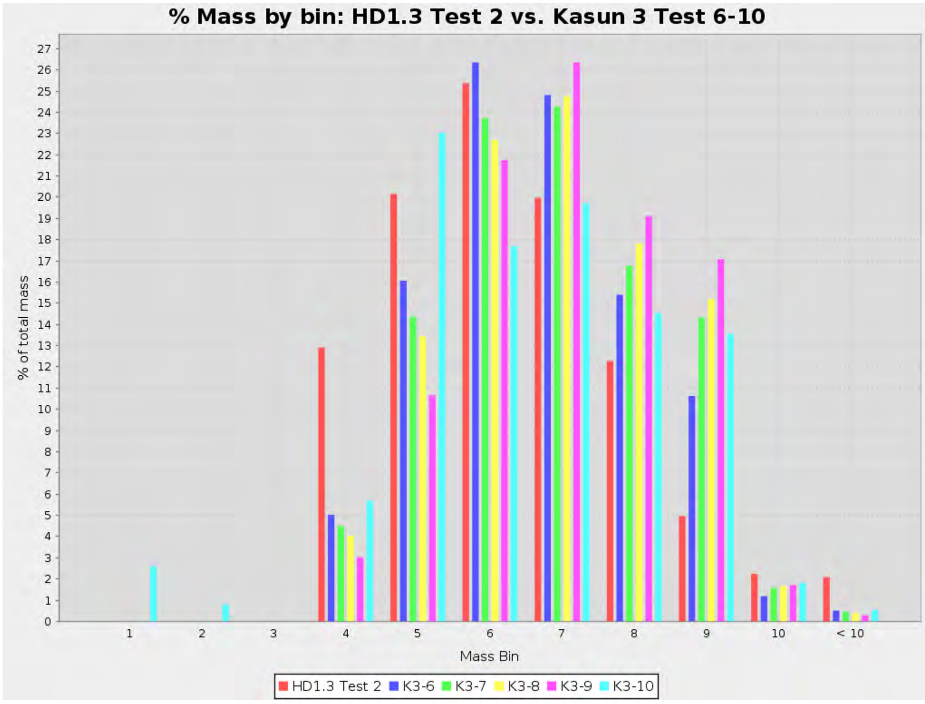


(a) Test 2.

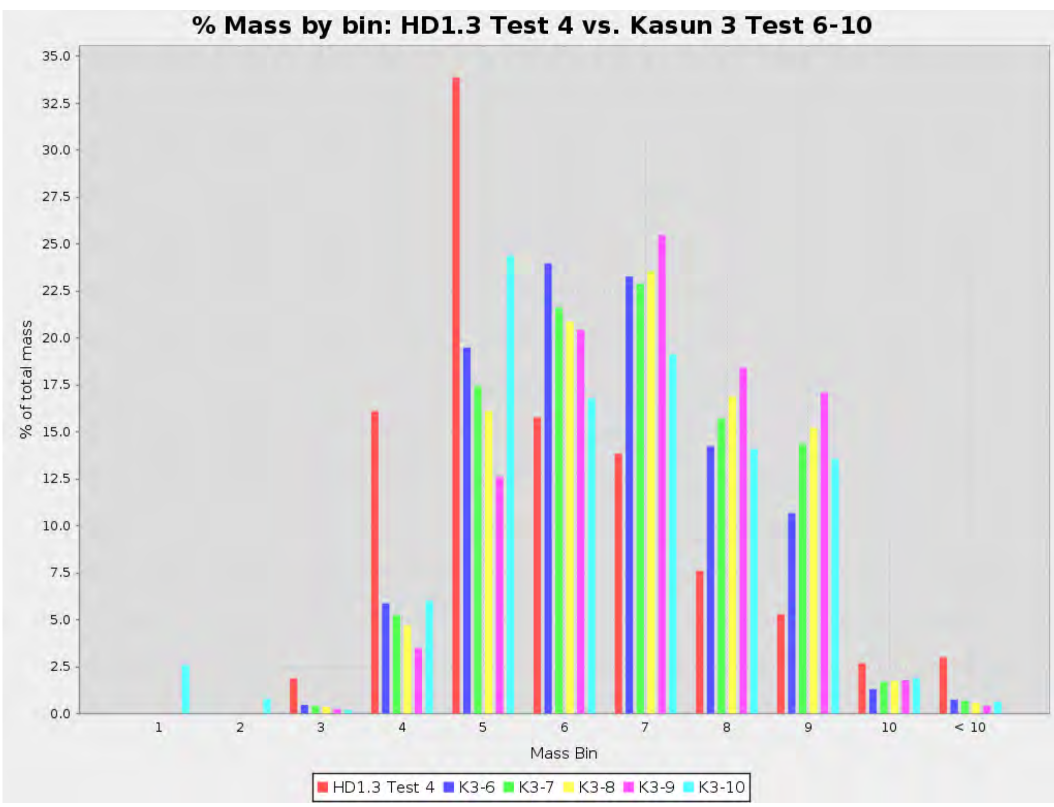


(b) Test 4

FIGURE VI-10. Mass Distribution by Bin.



(a) Test 2.



(b) Test 4.

FIGURE VI-11. Kasun III Data Comparison to HD1.3.

FAST RUNNING MODELS

A need exists to improve the current siting toolset for HD1.3 materials. The high-fidelity, physics-based tools have demonstrated the ability to predict the pressurization and potentially predict the fragmentation of the structure. These models run on multiple processors and can take hours to weeks to complete. The need to develop fast running models that can run in seconds to minutes is required for developing site plans that can be used in the field. ACTA Inc. was tasked to start working on these models. Their initial approach can be found in Appendix VI-B. They have taken a hybrid approach looking at both current fast running models to predict pressurization of the structure and fragment throw and high-fidelity models to examine structure fragmentation. The framework begins with determining if the HD1.3 material is in an open or confined structure. If in a confined structure, it will then determine if the flow will be choked or unchoked. If unchoked, a thermal-only calculation will be used versus choked where both an over-pressurization and thermal calculation will be used. A graphical representation of the hierarchy can be found in Figure VI-12. They were able to duplicate the pressurization of the structure in Test 4. Four different types of fragmentation models were examined in this study. The four fast running models that were proposed need to be further matured to assess which one is the most viable in the future.

FIGURE VI-12. Graphical Hierarchy of Fast Running Model Development.

FUTURE TESTING/PREDICTIONS

Additional testing is desired using a Kasun type structure with HD1.3 material. Two additional tests are planned: an unchoked flow condition (duplicate of Tests 1 and 3) to better quantify the plume length and width, and a choked flow condition (duplicate of Tests 2 and 4) with a structure that had the door tied in better. One additional follow-on test is also being considered that might lead to a "worst case" scenario and help determine which condition could lead to the farthest fragments being thrown. In this assessment, two main conditions are being examined. The first is to determine if the M1 gun propellant could run to detonation after ignition, thus pressurizing the structure. A shock would then be applied, causing the structure to fragment. The second condition being explored is burning the propellant inside the structure in different configurations. This would explore the effects of different pressurization rates and could identify which rate causes the structure to fail and fragment, thus producing a "worst case" condition based on the fragment velocity at time of failure.

DEFLAGRATION TO DETONATION TRANSITION

A numerical model, Naval Weapons Center Deflagration-to-Detonation Transition Code (NWCDDT) developed previously at China Lake, was used to evaluate the likelihood of a deflagration-to-detonation transition (DDT) (References VI-10 and VI-11). Members of the Combustion Sciences Branch performed the study. The model simulates the combustion of a tube packed with energetic material. The model requires inputs such as burning rate, thermodynamic properties, mechanical properties, flame properties, ignition treatment, etc. The model simulates the DDT event in a one-dimensional manner, with a two-dimensional treatment of the tube and its failure. NWCDDT was developed and used previously to study DDT events of HMX, RDX, AP, and other energetic materials.

The literature was searched to determine suitable properties for M1, with M10 properties being used as needed for missing properties. The formulations of the propellants are given in Table VI-2. Reported burning rates varied between authors; those reported by Grollman were selected for this work (Reference VI-12). Mechanical properties for the energetic particles were taken from previous NWCDDT calculations for other energetic materials such as HMX, as these could not be found for M1. The shape of a particle is accounted for with a shape factor to indicate how the actual shape deviates from a sphere. In the case of the current material, perforated cylinders, this parameter was varied to investigate its impact on the results.

TABLE VI-2. Formulation of M1 and M10 by Weight Percent.

	M1	M10
NC	83.11	98
Ethyl Alcohol	0.75	--
DPA	0.98	1
DNT	9.77	--
DBP	4.89	--
Water	0.5	--
Potassium Sulfate	--	1
Graphite	--	0.1

All calculations performed with the NWCDDT model resulted in non-DDT events. Compared to standard explosives, M1 is less reactive. This can be seen in Figure VI-13, which compares the linear burning rate of HMX and M1. M1's burning rate is roughly half that of HMX. Additionally, the loading density of M1 in the drums is only 38% TMD due to the shape of the particles. High loading densities in the range of 60% and higher are more typical of DDT events. Thus, the lower reactivity and the low packing density indicate that M1 will not undergo a DDT event in the current configuration.

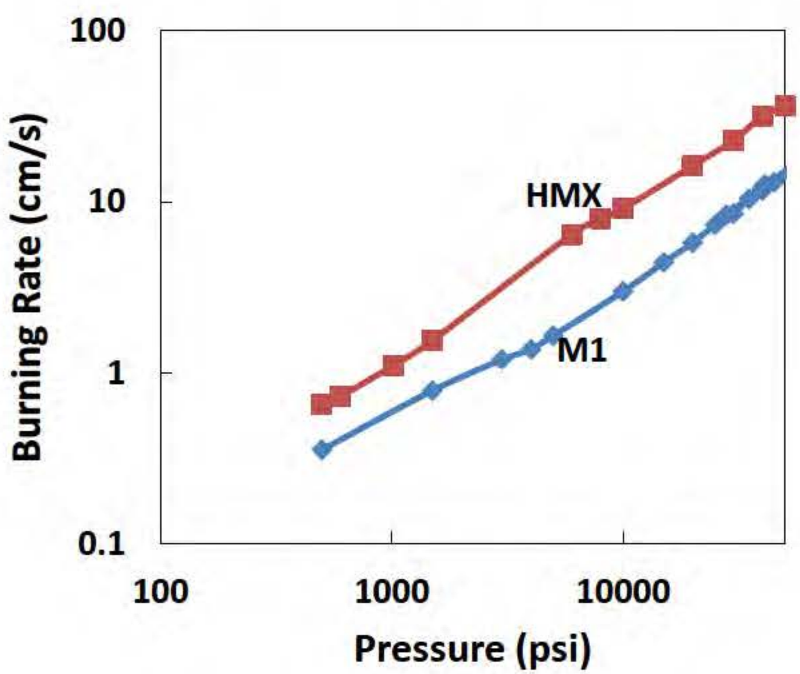


FIGURE VI-13. Burning Rates of Pure HMX and M1 Propellant.

PRESSURIZATION OF THE STRUCTURE

High-fidelity, physics-based models were used to determine which propellant condition may lead to the farthest distance that a fragment is thrown. The Combustion Sciences Branch developed the pressurization traces inside the structure that NAVFAC EXWC then implemented into their structural code to determine which condition caused the most damage leading to the farthest fragment thrown. Three parameters were varied in this study: the loading density of the structure, the propellant burning surface area, and the size of the exit orifice.

The ANSYS Fluent CFD simulations developed previously were used to determine the pressurization rate inside the structure. The burning of the propellant was modeled as an input flow rate. This input flow rate was determined from Tests 2 and 4. The input flow would cause the structure to pressurize with flow exiting out the orifice in the front of the structure. The propellant burn area was varied by changing the input flow rate. The loading density inside the structure was modeled by having the M1 gun propellant occupying either a quarter of the magazine (similar loading density as Tests 2 and 4) or increased to half the magazine. The simulations were run until a steady state condition was achieved. Figure VI-14 shows the results of the simulation. When the results were compared to experimental data P1 and P6, the model using same loading density and same flow rate curve resulted in pressures lower than the experimental data. Increasing the loading density did not significantly change the pressurization rate inside the structure since the amount of material burning at any one time did not change; the propellant just burned for a longer time. The propellant burning surface area and the orifice size caused the most change in the pressurization rate. It should also be noted that the pressure traces produced in this study were longer than what would be observed during a test due to the structure rupturing. The models predicted that under chocked flow conditions the largest pressurization of the structure would occur with a smaller orifice size (0.195-cm versus 0.39-cm diameter) and with increased surface area. The vent area ratio in this calculated situation would be 0.0075, lower than anything that has been currently tested.

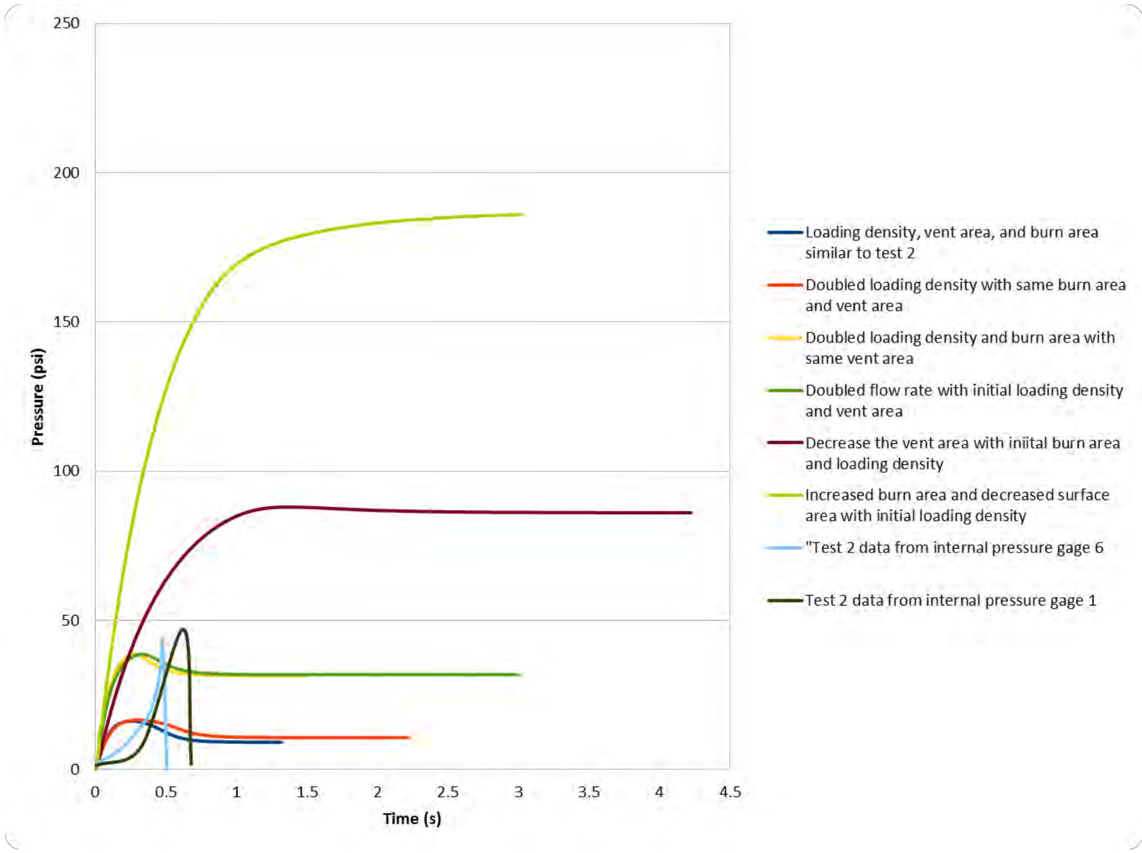


FIGURE VI-14. Predicted Pressure Versus Rime Curves.

The CFD program LS-DYNA was once again used to model the structural behavior of the Kasun structure for the three future test conditions discussed in the future testing/predictions section. A new Kasun model was developed in this study based on the documented construction of the new test structures. The details of the new model can be found in Reference VI-13. Based on the experience in modeling Tests 2 and 4, the lap splices were explicitly modeled so that both an upper and lower bound lap splice strength could be achieved. The pressures generated from the ANSYS Fluent calculations were applied uniformly to the structure. Four of the pressure conditions were examined in this study. Initial analysis indicated that two conditions would result in the structure to stay intact, both conditions require a flow rate similar to that modeled for Tests 2 and 4, but the loading density can be increased or remain the same as that observed in Tests 2 and 4 (Reference VI-13).

The model predicts the "worst case" loading scenario to use the smaller orifice with the increased burn area and the same loading density (as Tests 2 and 4). Figure VI-15 shows the failure of the structure at approximately 0.42 seconds and how it breaks apart. The pressure at the point of failure is 60 psi. The break-up time and the pressure at failure for the other models can be found in Table VI-3. In general, the models predict

failure toward the bottom of the structure with the potential for the floor to fragment and the walls to pull apart from the floor versus what was seen in Tests 2 and 4 with the roof failing and walls pulling apart from the roof (Reference VI-13).

(a) 0.424 s. (b) 0.45 s.

FIGURE VI-15. Increased Flow Rate and Larger Orifice With Same Loading Density.

TABLE VI-3. Break-up Time and Blast Pressure for Full Connection Models.

Orifice Size	Flow Rate	Occupied	Failure Time, second	Blast Pressure, psi
Smaller orifice (0.195 cm)	Doubled	Doubled loading	0.420	60.0
Smaller orifice (0.195 cm)	Same Flow	Same loading	0.545	52.4
Regular orifice (0.39 cm)	Doubled	Same loading	0.545	39.5
P1	N/A	N/A	0.858	47.0

SUMMARY

High-fidelity, physics-based modeling tools were used to predict and understand the reaction of M1 gun propellant, a HD1.3 material, in a concrete structure. The CFD code ANSYS Fluent was used to predict the pressurization of the structure. The pressure-time histories from the experiments were then used in LS-DYNA to determine the structural response. Mixed results were seen in duplicating the response of the structure due to a lack in detail on how the structure was constructed. The response for Test 2 was similar to that modeled in LS-DYNA. However, when the pressure profile of Test 4 was used, the structure did not fail.

The simulations were also used to determine the potential “worst case” condition for throwing the farthest fragments. ANSYS Fluent was used to generate the pressure time curves to assess the effect of increasing the loading density, increasing the burning propellant surface area, and increasing the diameter of the orifice of the structure. The pressure time curves were then used as an input into the LS-DYNA calculation to determine which condition would cause the most damage and would throw a fragment the farthest. It was determined that increasing the burning propellant surface area and decreasing the orifice of the structure had the most likely chance of throwing a fragment the farthest. The calculations also showed that the failure of the structure would most likely occur near the floor region versus toward the roof as seen in Tests 2 and 4.

Analysis was also performed to assess the limitations of the current siting methodologies. Both risk based and quantity distance criteria were inadequate in estimating either the fragmentation or the thermal hazard created from the HD1.3 event. However, attempts to utilize either HD1.1 siting criteria or TNT NEW criteria over-estimated the hazard. Work is currently underway to develop models that will be able to predict both the thermal and fragmentation hazard.

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Appendix VI-A

APT-RESEARCH ANALYSIS

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1. Introduction

APT-Research (APT) was tasked to compare the DDESB/NAVAIR confined HD 1.3 tests (November-December 2012) results using current Department of Defense Explosives Safety Board (DDESB) approved analysis tools. These tools include the ESS (Explosives Safety Siting) software (Reference VI-A-1) and the SAFER (Safety Assessment For Explosives Risk) software, as described in DDESB Technical Papers 14 and 19 (References VI-A-2 and VI-A-3). The two software packages were chosen to provide parallel assessments of the confined HD 1.3 test series. SAFER could be used to quantify the risks associated with the event, as an alternative to the QD approach with ESS.

The confined HD 1.3 test series has been designed to study the transition from deflagration to detonation due to confinement and reduced vent area. Department of Defense Explosive Safety Manual 6055.09-M (Reference VI-A-4) identifies that an increased risk of detonation is possible when HD 1.3 explosives are stored in confined locations as this test may produce. Therefore, the results were also evaluated as HD 1.1 considering the possibility that the test material detonated as high explosive material.

> *V1.E8.4.1.3. Where there is minimal venting and structural containment (extreme confinement), a detonation of the HD 1.3 may occur with effects similar to those of an HD 1.1 explosion.*
>
> *V1.E8.4.2. Fragments. In an HD 1.3 event, fragments are considerably less hazardous than those produced by HD 1.1 and HD 1.2 events. Internal gas pressures may produce fragments from the bursting of containers or the rupture of containment facilities. In general, such fragments will be large and of low velocity.*

It is understood that modeling these tests as either a standard HD 1.3 event or a full HD 1.1 event with current methodologies will not produce ideal results. The intent of this task is to study the output of current DDESB-approved analysis tools in comparison with this test series.

For both ESS and SAFER analyses, three scenarios were considered:

1. Modeling the scenario strictly as a HD 1.3 event with current methods (Full NEW)
2. Modeling the scenario strictly as a HD 1.1 event with current methods (Full NEW)
3. Modeling the scenario as a modified HD 1.1 event with a TNT equivalency of 85%

These three options will be referred to throughout the ESS and SAFER modeling sections as Scenarios 1 through 3.

Details for the inputs and results of these studies for both ESS and SAFER are provided.

Section 1.1 describes the limitations of using a TNT equivalence and Section 1.2 describes the analysis performed to determine the TNT equivalence value used in Scenario 3 in Sections 2 and 3 (Note: this value was not used in the other two approaches).

1.1. Limitations to the use of a TNT Equivalency

Equating a material to TNT by use of a scaling factor allows many energetic materials to be analyzed with standard HD1.1 techniques. In each case the scaling factor, or TNT equivalence, must be obtained through analysis and/or testing. Even though this method is useful in many circumstances, it is acknowledged that TNT equivalencies are not ideal for capturing the independent behavior of overpressure, impulse, and debris in the confined HD 1.3 events. The overpressure and impulse behaviors can sometimes be modeled by running multiple analyses individually tuned to one of the behaviors, but even this type of analysis is not ideal. The DDESB-approved software tools used in this study do not have the capability to fully model the confined behavior of HD 1.3 events in their current formats. The TNT equivalency method is used in these analyses (Scenario 3) with this caveat in mind.

1.2. TNT Equivalency methodology

In 1994, the Naval Surface Warfare Center conducted a series of tests to determine the TNT equivalency of three selected U.S. Army gun propellants, including M1 – the propellant used in the confined HD 1.3 tests. The tests utilized relatively large stacks of material (Net Explosive Weight on the order of 2,000 pounds) and were conducted by placing the material inside a heavy-walled concrete pipe (simulating magazine-type confinement) and attempting to detonate one or more of the items.

Airblast was measured outside the structure. Equivalent yield and TNT equivalency were then determined from the airblast. The material exhibited energetic reactions which approached detonation and gave yield approximately that of an equal weight of TNT.

Utilizing techniques developed and defined in the analysis of nuclear blast yields, an absolute yield in megacalories can be determined for any pressure-distance curve. These concepts have been refined and incorporated into Porzel’s Unified Theory of Explosions (Reference VI-A-5). Although the technique was developed for spherical or hemispherical detonations, it has been successfully applied to cylindrical data as well (References VI-A-6 and VI-A-7). These results from the 1994 tests are shown in Figure VI-A-1. Not surprisingly, they do not differ significantly from the results obtained from an equivalent weight analysis. Using least squares curve fits, equivalent weights based on peak pressure and positive impulse were also calculated.

	PROPELLANT TYPE					
	M6		M1		M30A1	
	Pure	Mixed*	Pure	Mixed*	Pure	Mixed*
PRESSURE	0.70	0.93	0.82	1.31	1.81	1.06
IMPULSE	0.63	1.20	0.75	1.06	1.41	1.31
UTE-YIELD	0.73	1.11	0.85	1.63	2.01	1.50

(note: all values averaged over the pressure range of 2-100 kPa)

* with M107 155 mm projectiles

Figure VI-A-1 - Equivalent Weight/Yield Summary

Based on the outcome of the 1994 test series and the similarity to the confined HD 1.3 tests, a TNT equivalency of 0.85 was used to estimate the effects. However, this was only viewed as a starting point, because since the M1 was initiated by detonation in 1994, it was fully anticipated that the modeling would indicate more violent outcomes than for HD 1.3 initiated via less severe means.

Therefore, equivalent NEW, W_2, was calculated using the following formula (Equation 15 of Reference VI-A-2).

$$W_2 = W_1 * TNT\ conversion\ factor$$

Using this equation, the NEW values are modified for use in the third analysis scenario. These values are presented in Table VI-A-1.

Table VI-A-1 – Full and modified NEW quantities

Test	NEW (HD 1.3)	85% TNT equivalent (HD 1.1)
Test 1	296 lbs	252 lbs
Test 2	1,176 lbs	1,000 lbs
Test 3	264 lbs	224 lbs
Test 4	1,108 lbs	942 lbs

2. ESS Analysis

The process of loading the test results into ESS involved several steps. These steps included:

- Creating an empty ESS map to conduct the assessment
- Loading the facility information from the test results
- Calculating definite results when standard minimum distances were applied by ESS

- Interpreting all of the results, and
- Creating quantity distance (QD) maps of results using current QD criteria.

Data for conducting an ESS evaluation were gathered from test results information provided by China Lake. This included the size of the test structures and the net explosive weight (NEW) of each test.

A blank ESS map was first created to load and evaluate the test facilities. All test facilities involved a 2 meter cube (2m x 2m x 2m). Because ESS is based on a two dimensional aerial view, a 2 meter x 2 meter square footprint was loaded into the software. (The English equivalent of 2 meters is 6.5616 feet so a 7 foot footprint was used.)

For each of the three scenarios described in Section 1, four (4) test facilities were loaded into ESS to represent the HD 1.3 tests. The names of these facilities are presented in Table VI-A-2.

Table VI-A-2 - ESS cases

Test	Facility Number	NEW (HD 1.3)
Test 1	Cube 1	296 lbs
Test 2	Cube 2	1,176 lbs
Test 3	Cube 3	264 lbs
Test 4	Cube 4	1,108 lbs

This process was repeated, adding facilities 1A-4A to model the HD 1.1 scenario (Scenario 2) and facilities 1B-4C to model the modified HD 1.1 scenario (Scenario 3).

Once all facilities were loaded, an ESS spatial analysis and QD analysis were completed to create the QD arcs and drawings as shown in Figure VI-A-2.

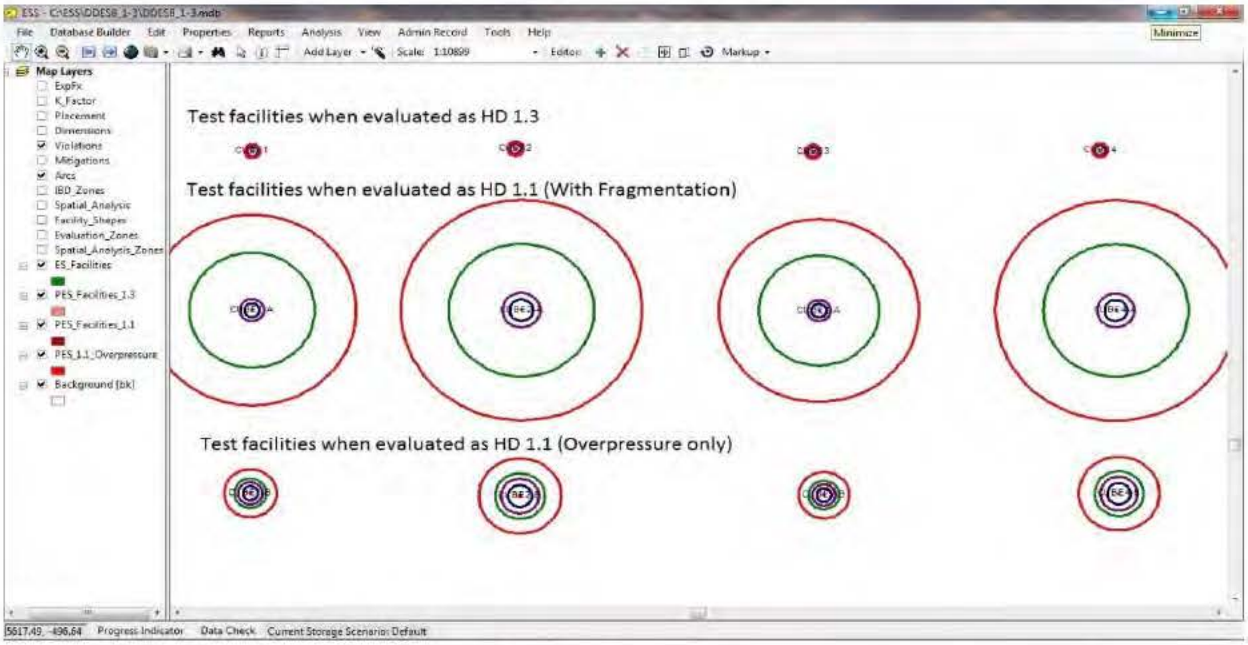

Figure VI-A-2 - Screenshot of ESS implementation

2.1. HD 1.3 Event

The HD 1.3 scenario is detailed first. The PES variables within ESS were set as shown in Table VI-A-3.

Table VI-A-3 - ESS Scenario 1 inputs

ESS Data Requirement	Input
PES Building Type Code	Above Ground Magazine (AGM)
Structure Type	Aboveground Site Heavy Wall and Roof
Fragments Contained	No
Open Location	No
Reinforced Openings	No
Combustible Facility	No
Remote Location	No
Hazard Division	1.3
Fragmenting Item	N/A – Defaults to Yes

Individual maps were created for each test using standard HD 1.3 criteria. The resulting QD values are shown in Table VI-A-4 and Figures VI-A-3 through VI-A-6.

Table VI-A-4 - ESS Scenario 1 results

Test	Facility #	NEW	Type	IBD	PTRD	ILD	IMD
Test 1	Cube 1	296 lbs	HD 1.3	75'	75'	50'	50'
Test 2	Cube 2	1176 lbs	HD 1.3	76'	75'	50'	50'
Test 3	Cube 3	264 lbs	HD 1.3	75'	75'	50'	50'
Test 4	Cube 4	1108 lbs	HD 1.3	75'	75'	50'	50'

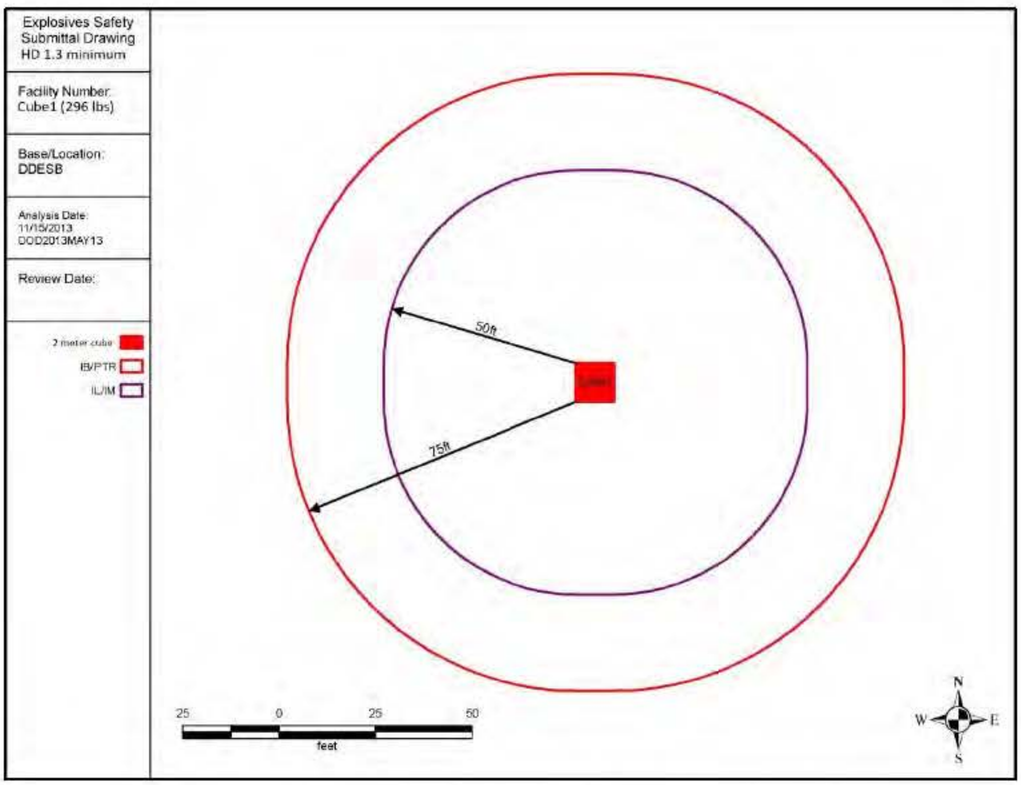

Figure VI-A-3 – ESS QD arcs for Scenario 1 Test 1

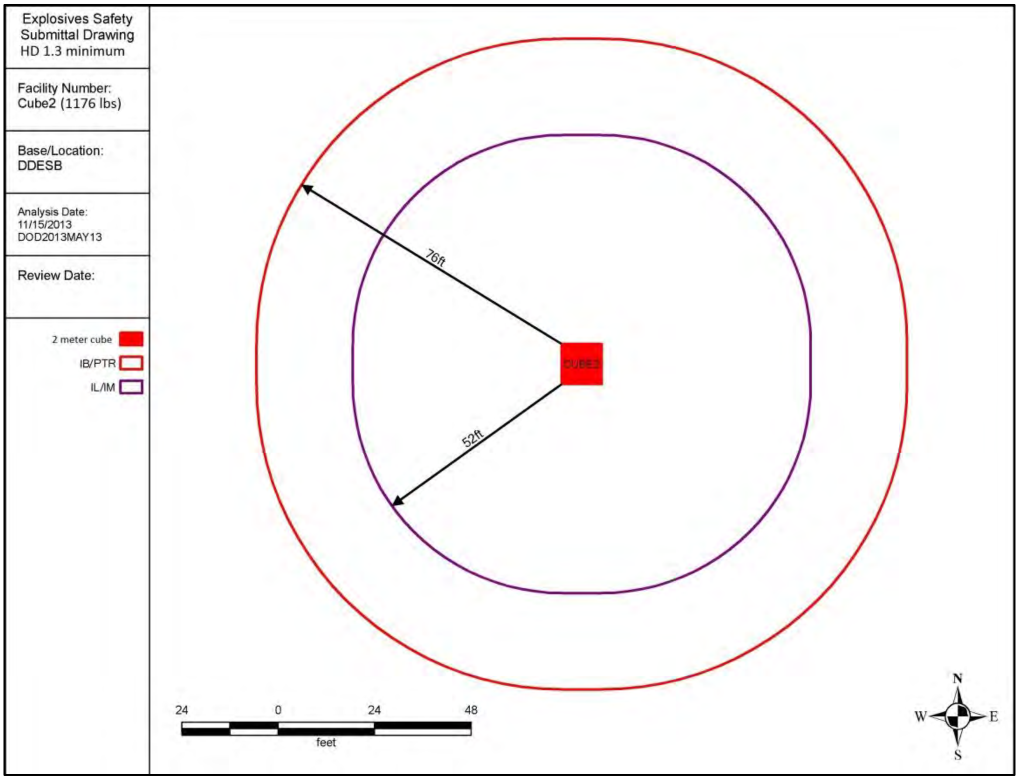

Figure VI-A-4 – ESS QD arcs for Scenario 1 Test 2

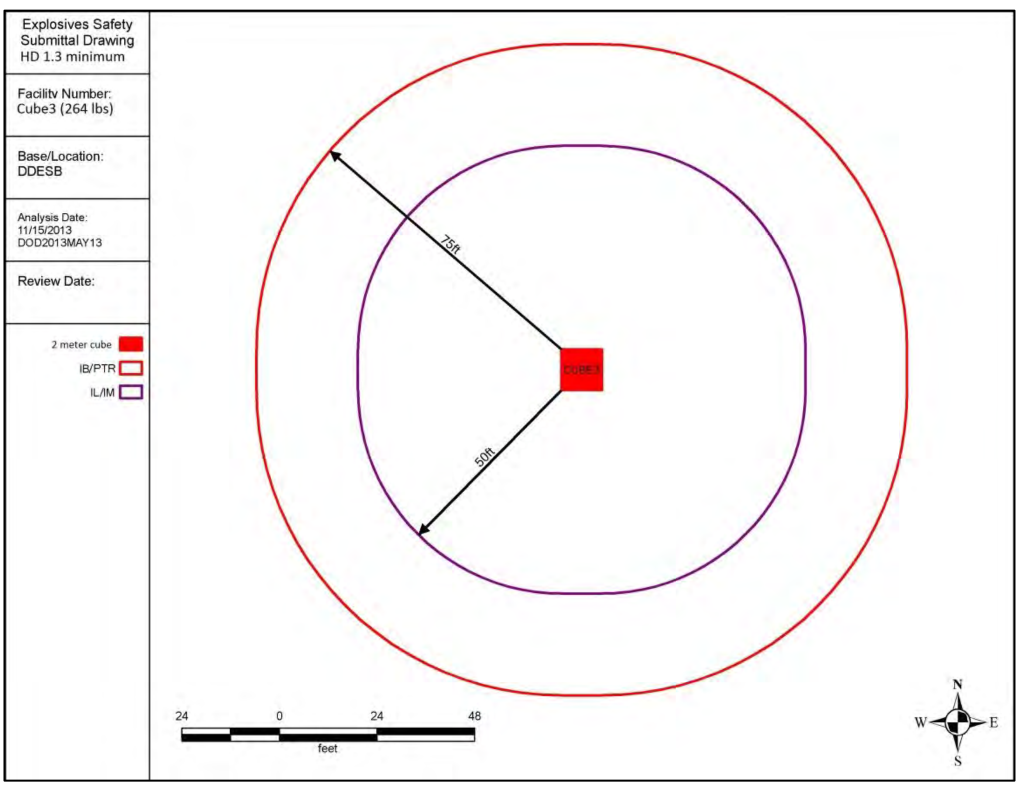

Figure VI-A-5 – ESS QD arcs for Scenario 1 Test 3

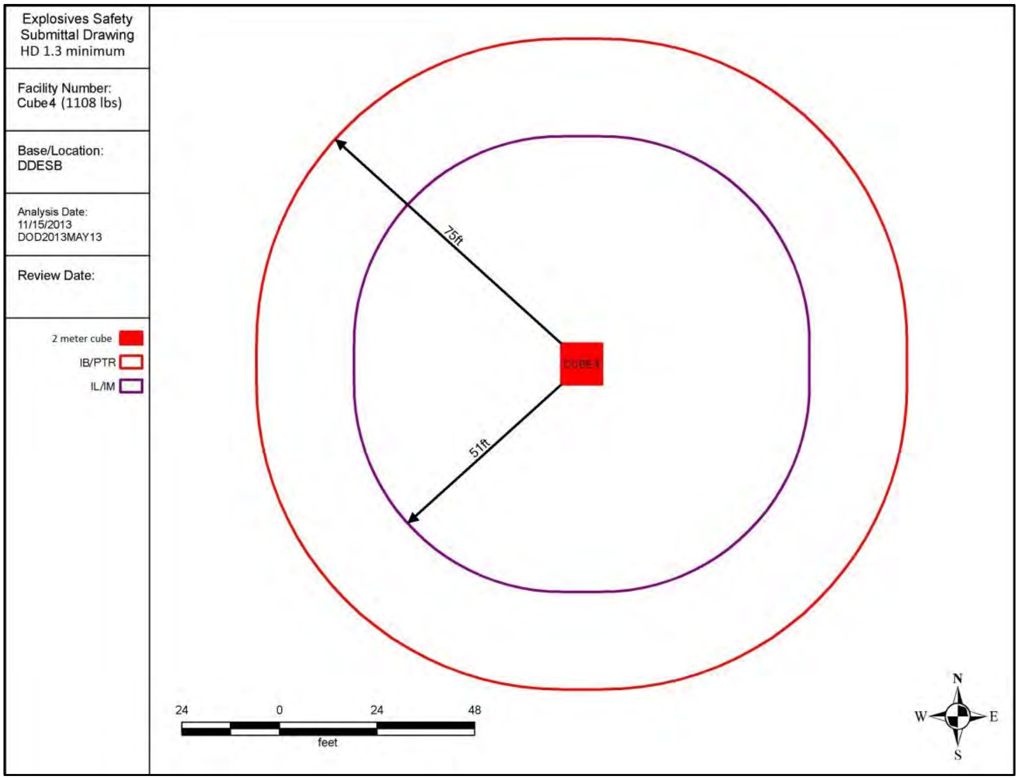

Figure VI-A-6 – ESS QD arcs for Scenario 1 Test 4

Two additional maps were created with test imagery that was available for Tests 2 and 4. These are shown as Figures VI-A-7 and VI-A-8. In these figures, the HD 1.3 Inhabited Building Distance (IBD) arc is shown as bright red line (the third-largest circle). The other circles represent radial distances used in the debris collection effort. It can be seen that the current QD arc for this NEW underestimates the hazards because fragmentation is not accounted for in HD 1.3 criteria.

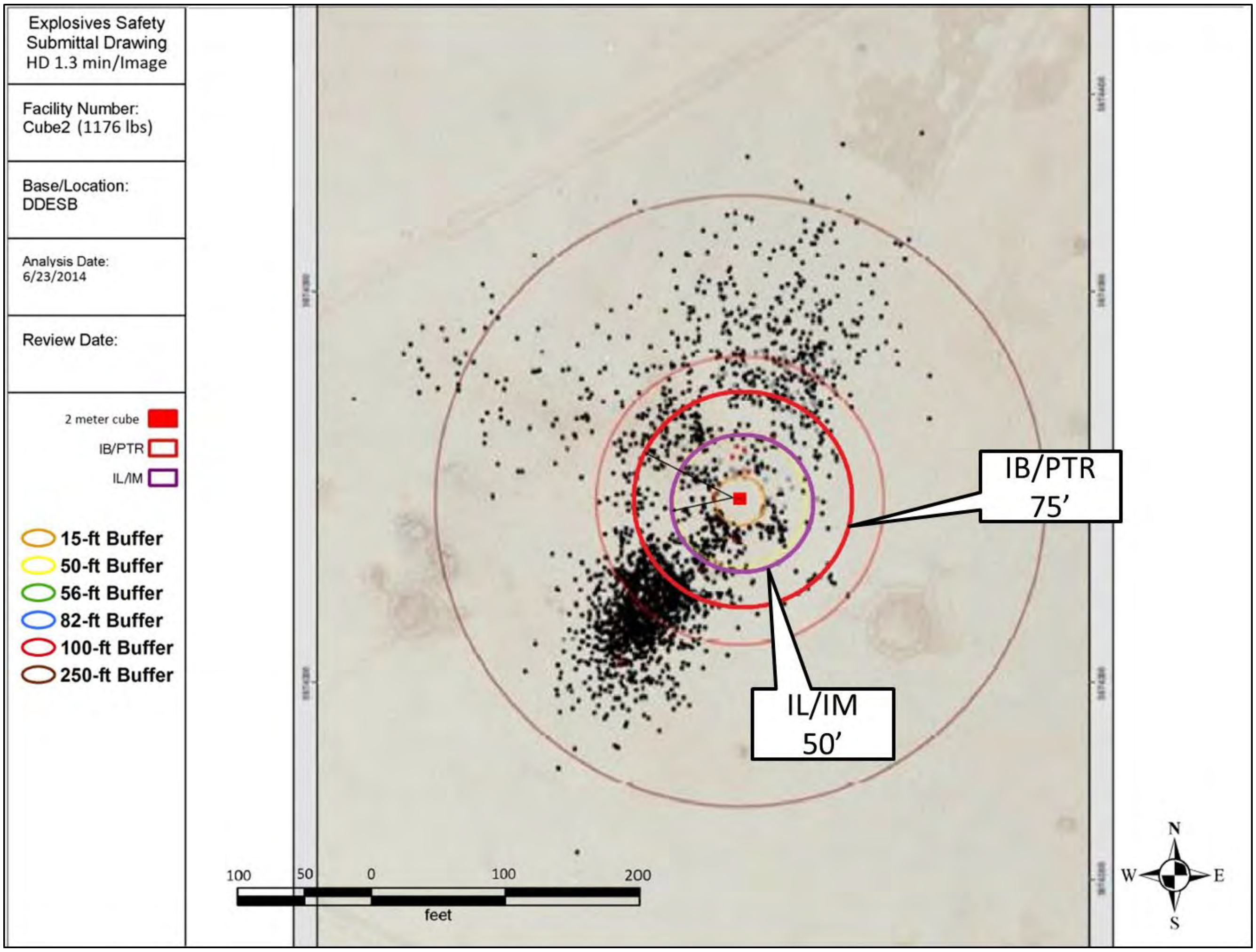

Figure VI-A-7 – ESS QD arcs for Scenario 1 Test 2 overlaid on debris collection map

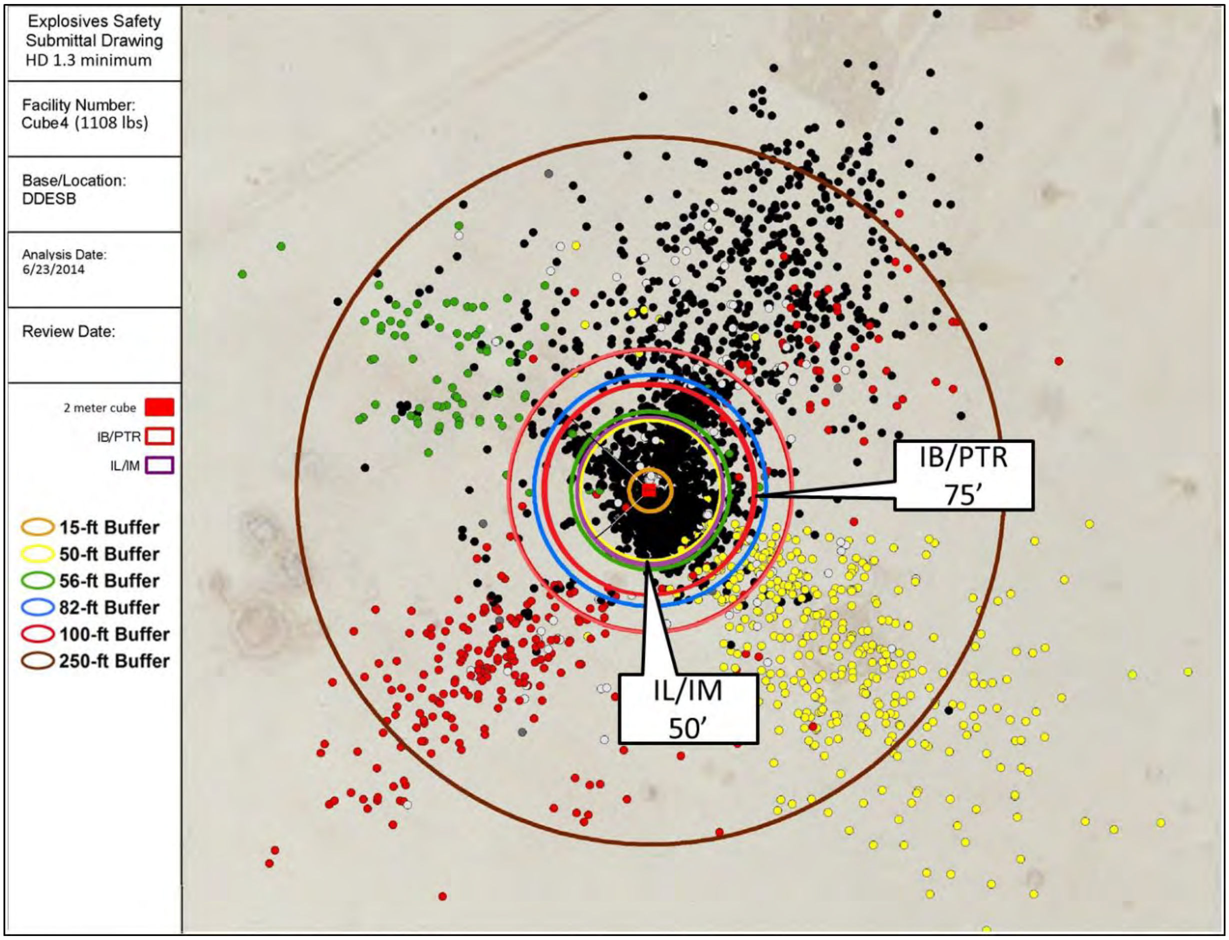

Figure VI-A-8 – ESS QD arcs for Scenario 1 Test 4 overlaid on debris collection map

2.2. Full HD 1.1 Event

The full HD 1.1 scenario, considering overpressure and fragmentation, is detailed next. The PES variables within ESS were set as shown in Table VI-A-5.

Table VI-A-5 - ESS Scenario 2 inputs

ESS Data Requirement	Input
PES Building Type Code	Above Ground Magazine (AGM)
Structure Type	Aboveground Site Heavy Wall and Roof
Fragments Contained	No
Open Location	No
Reinforced Openings	No
Combustible Facility	No
Remote Location	No
Hazard Division	1.1
Fragmenting Item	Yes

Individual maps were created for each test using standard HD 1.1 criteria. This scenario considers the overpressure and the hazardous frag distance (HFD). The HFD is calculated in accordance with Table V3.E3.T2 of Reference VI-A-4. The results are shown in Table VI-A-6 and Figures VI-A-9 through VI-A-12.

Table VI-A-6 - ESS Scenario 2 results

Test	Facility #	NEW	Type	IBD	PTRD	ILD	IMD
Test 1	Cube 1-A	296 lbs	HD 1.1 with HFD	1080’	648’	120’	73’
Test 2	Cube 2-A	1176 lbs	HD 1.1 with HFD	1250’	750’	190’	116’
Test 3	Cube 3-A	264 lbs	HD 1.1 with HFD	1035’	621’	115’	71’
Test 4	Cube 4-A	1108 lbs	HD 1.1 with HFD	1250’	750’	186’	114’

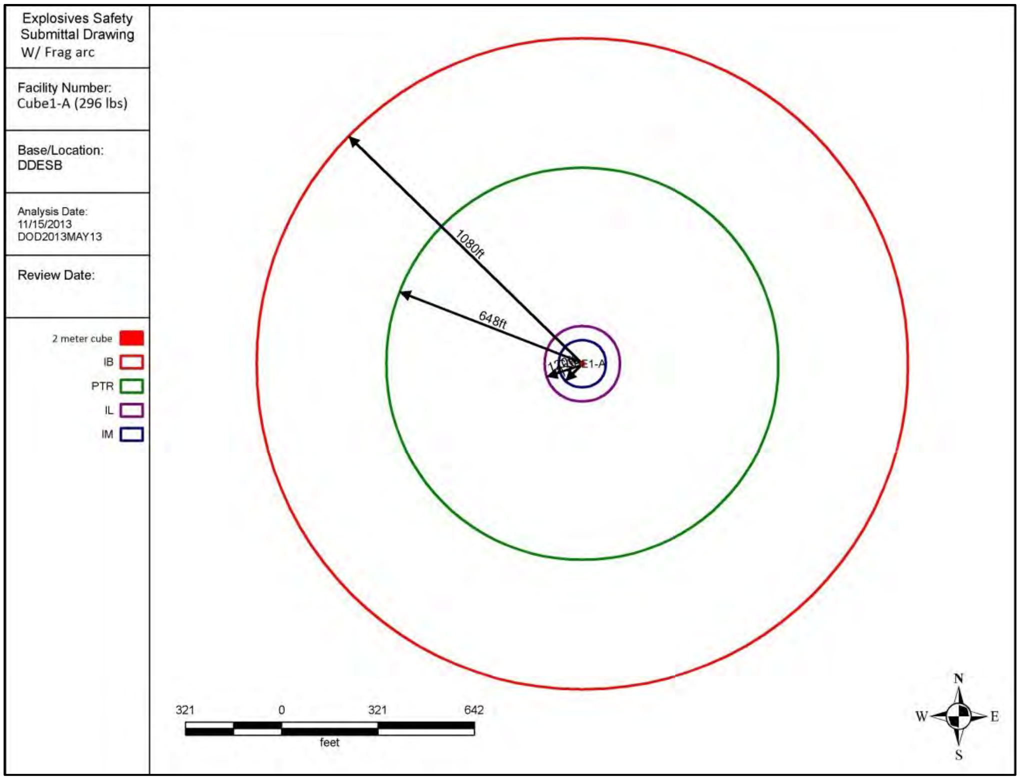

Figure VI-A-9 – ESS QD arcs for Scenario 2 Test 1

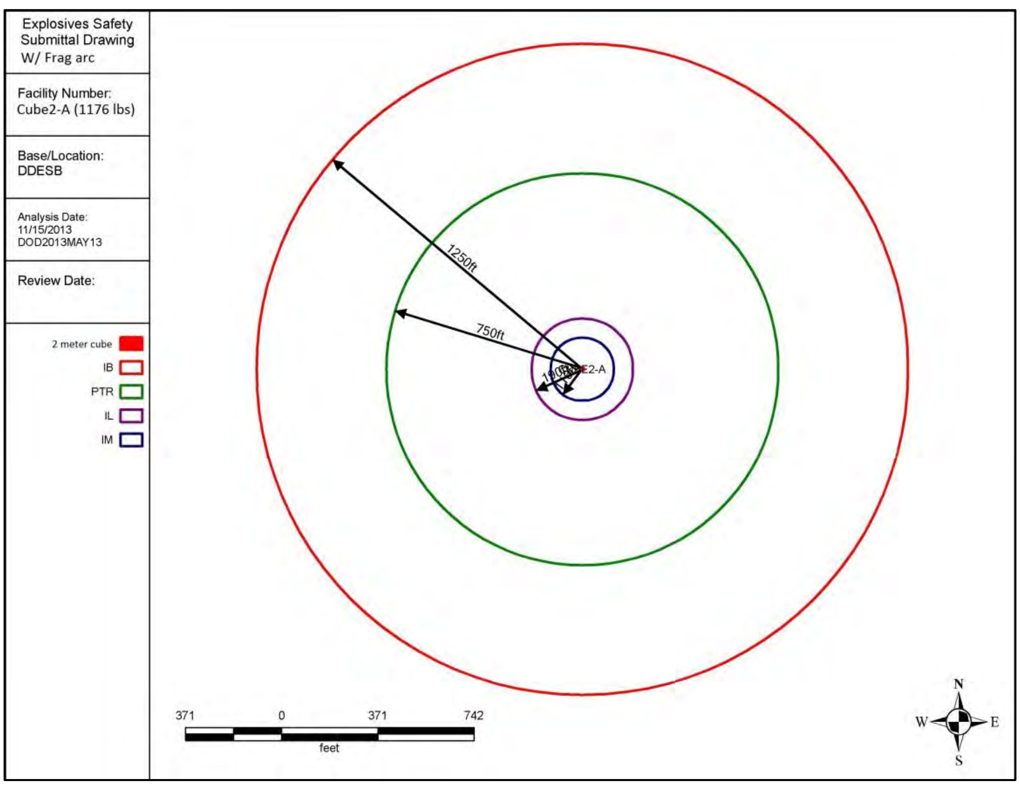

Figure VI-A-10 – ESS QD arcs for Scenario 2 Test 2

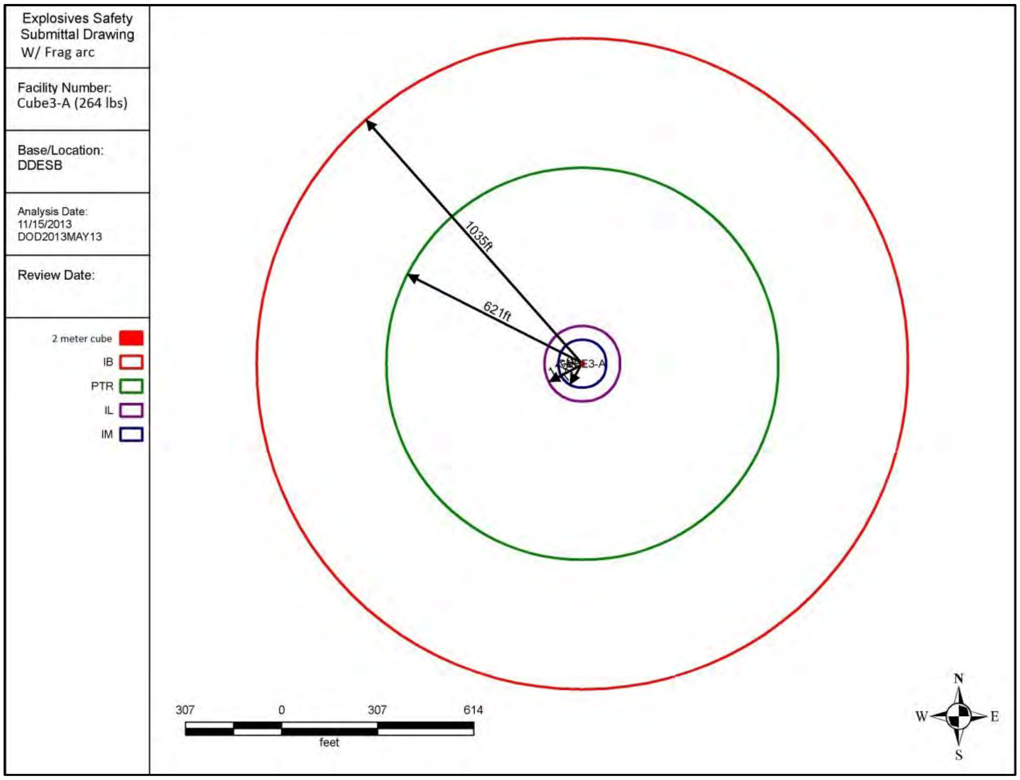

Figure VI-A-11 – ESS QD arcs for Scenario 2 Test 3

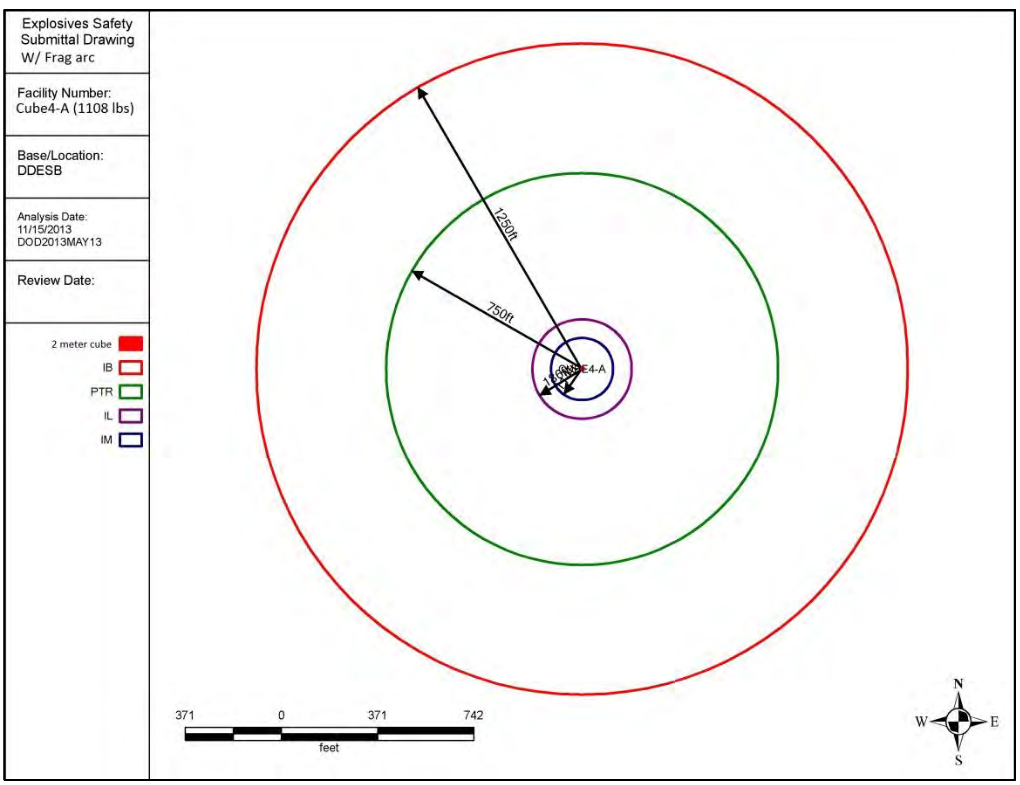

Figure VI-A-12 – ESS QD arcs for Scenario 2 Test 4

Two additional maps were created with test imagery that was available for Tests 2 and 4. These maps are presented as Figures VI-A-13 and VI-A-14. It can be seen that the current QD arc for this NEW overestimates the hazards because the fragmentation pattern produced by the current HD 1.1 QD criteria includes a conservative 1,250 ft arc. The fragments are seen to be highly directional along the angles normal to the walls. The debris density along the corners is not well represented by the IBD arc.

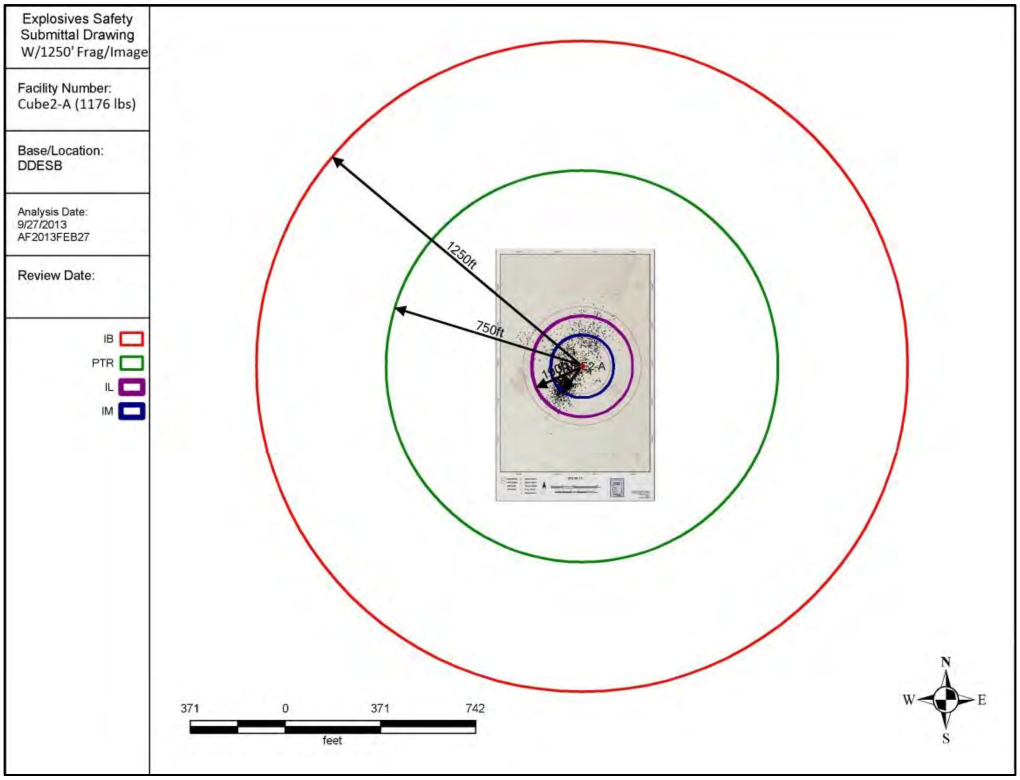

Figure VI-A-13 – ESS QD arcs for Scenario 2 Test 2 overlaid on debris collection map

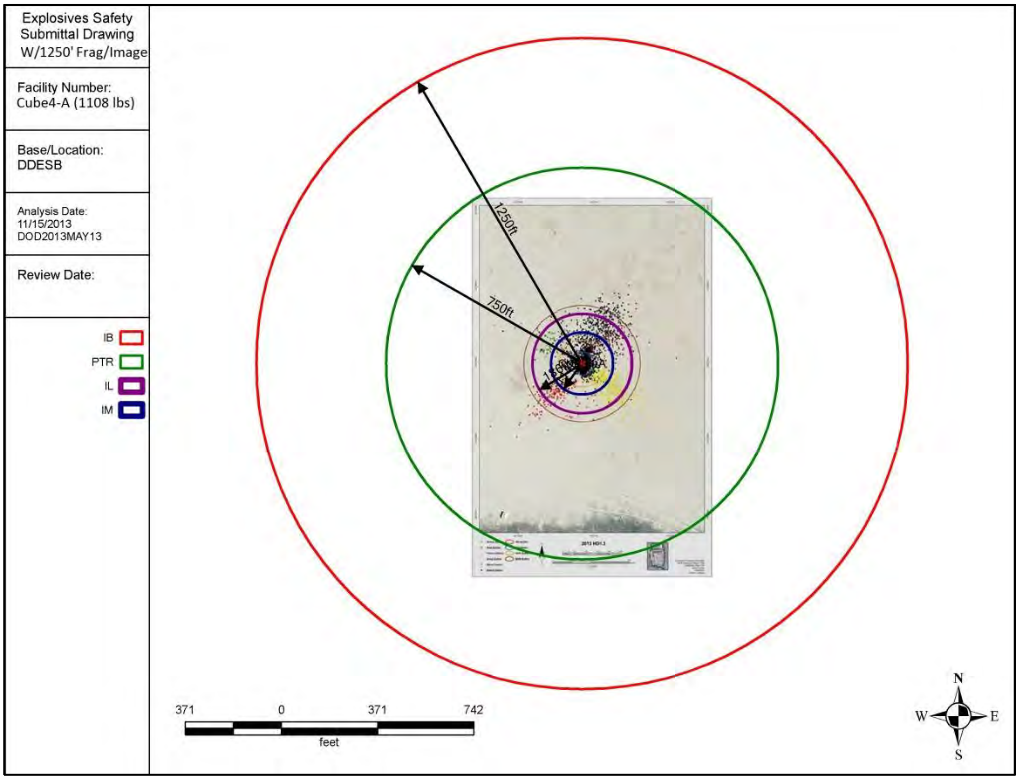

Figure VI-A-14 – ESS QD arcs for Scenario 2 Test 4 overlaid on debris collection map

2.3. Modified HD 1.1 Event

The final scenario described is an HD 1.1 event considering the TNT equivalency of 85%. Only overpressure arcs are represented in this scenario. Fragmentation arcs are important to consider, given that K-factor arcs are not intended to account for this hazard. However, the fragment arcs are not shown in this scenario because they would not change from the minimum 1,250 ft distance for Tests 2 and 4 and are already represented in the analysis of the second scenario. The requirement to consider fragment hazards is not removed, but is not the focus of this analysis scenario.

The PES variables within ESS were set as shown in Table VI-A-7.

Table VI-A-7 - ESS Scenario 3 inputs

ESS Data Requirement	Input
PES Building Type Code	Above Ground Magazine (AGM)
Structure Type	Aboveground Site Heavy Wall and Roof
Fragments Contained	Yes
Open Location	Yes
Reinforced Openings	No
Combustible Facility	No
Remote Location	No
Hazard Division	1.1
Fragmenting Item	No

Individual maps were created for each test using standard HD 1.1 criteria. This scenario considers the overpressure and the hazardous frag distance (HFD). The HFD is calculated in accordance with Table V3.E3.T2 of Reference VI-A-4. The results are shown in Table VI-A-8 and Figures VI-A-15-through VI-A-18.

Table VI-A-8 - ESS Scenario 3 outputs

Test	Facility #	NEW	Type	IBD	PTRD	ILD	IMD
Test 1	Cube 1-C	252 lbs	HD 1.1 Over Pres.	253’	152’	114’	69’
Test 2	Cube 2-C	1,000 lbs	HD 1.1 Over Pres.	400’	240’	180’	110’
Test 3	Cube 3-C	224 lbs	HD 1.1 Over Pres.	243’	146’	109’	67’
Test 4	Cube 4-C	942 lbs	HD 1.1 Over Pres.	392’	235’	176’	108’

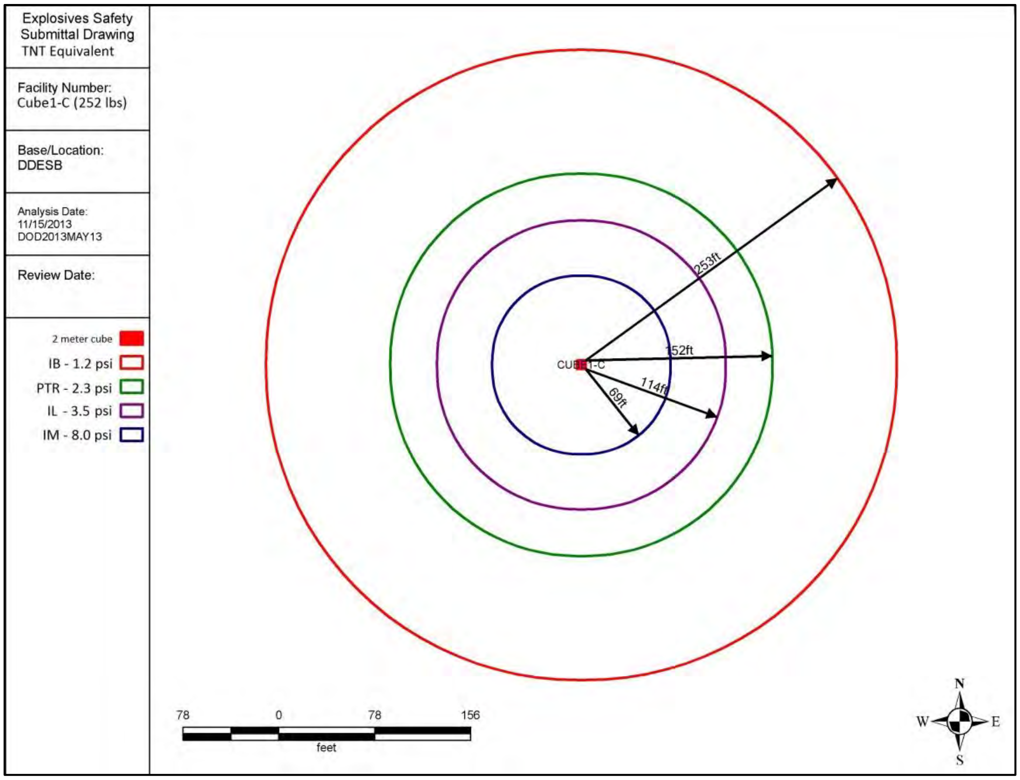

Figure VI-A-15 – ESS QD arcs for Scenario 3 Test 1

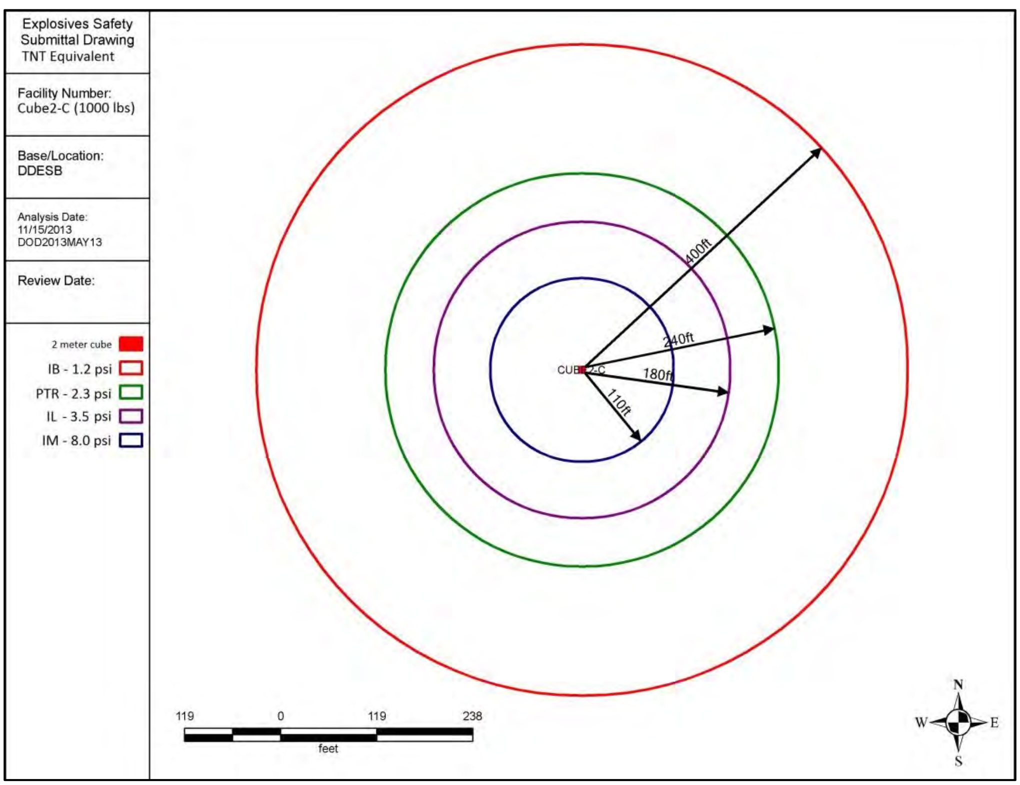

Figure VI-A-16 – ESS QD arcs for Scenario 3 Test 2

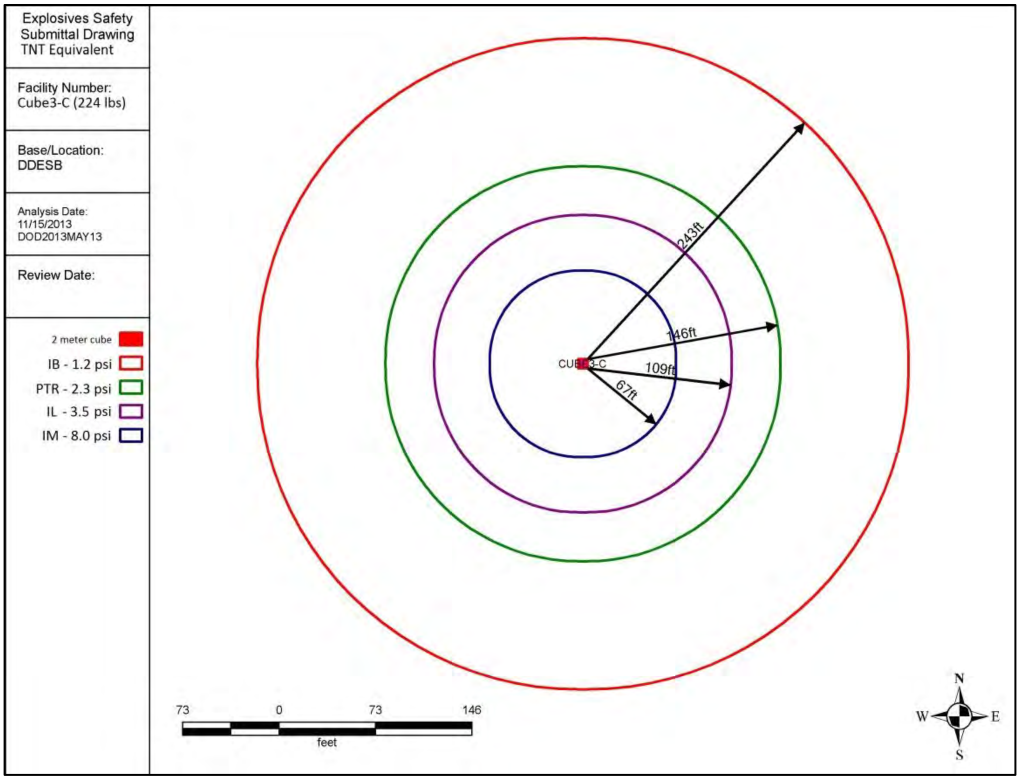

Figure VI-A-17 – ESS QD arcs for Scenario 3 Test 3

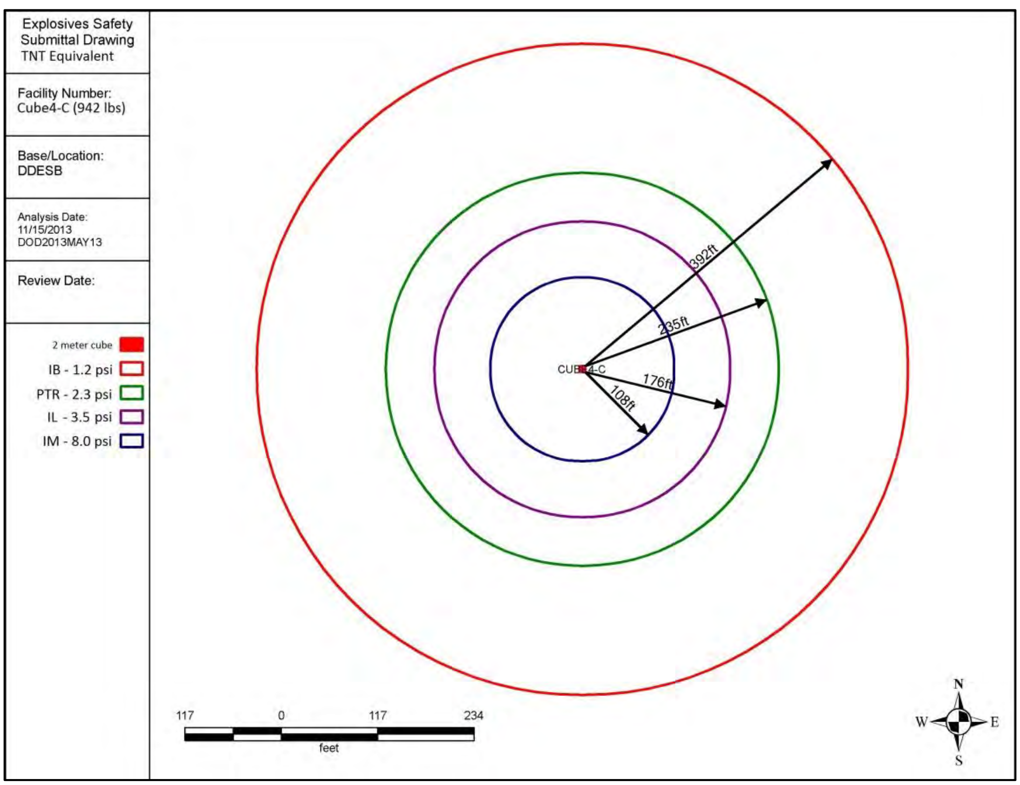

Figure VI-A-18 – ESS QD arcs for Scenario 3 Test 4

Two additional maps were created with test imagery that was available for Tests 2 and 4. These maps are shown as Figures VI-A-19 and VI-A-20. The modified HD 1.1 methodology of using overpressure arcs only does produce distances that are closer to the desired output, but the K-factor methodology does not accurately portray the behavior of the fragment hazards. Considering the minimum frag arc distance of 1,250 (for NEW greater than 450 lbs) would be too conservative and is shown in the analysis for scenario 2.

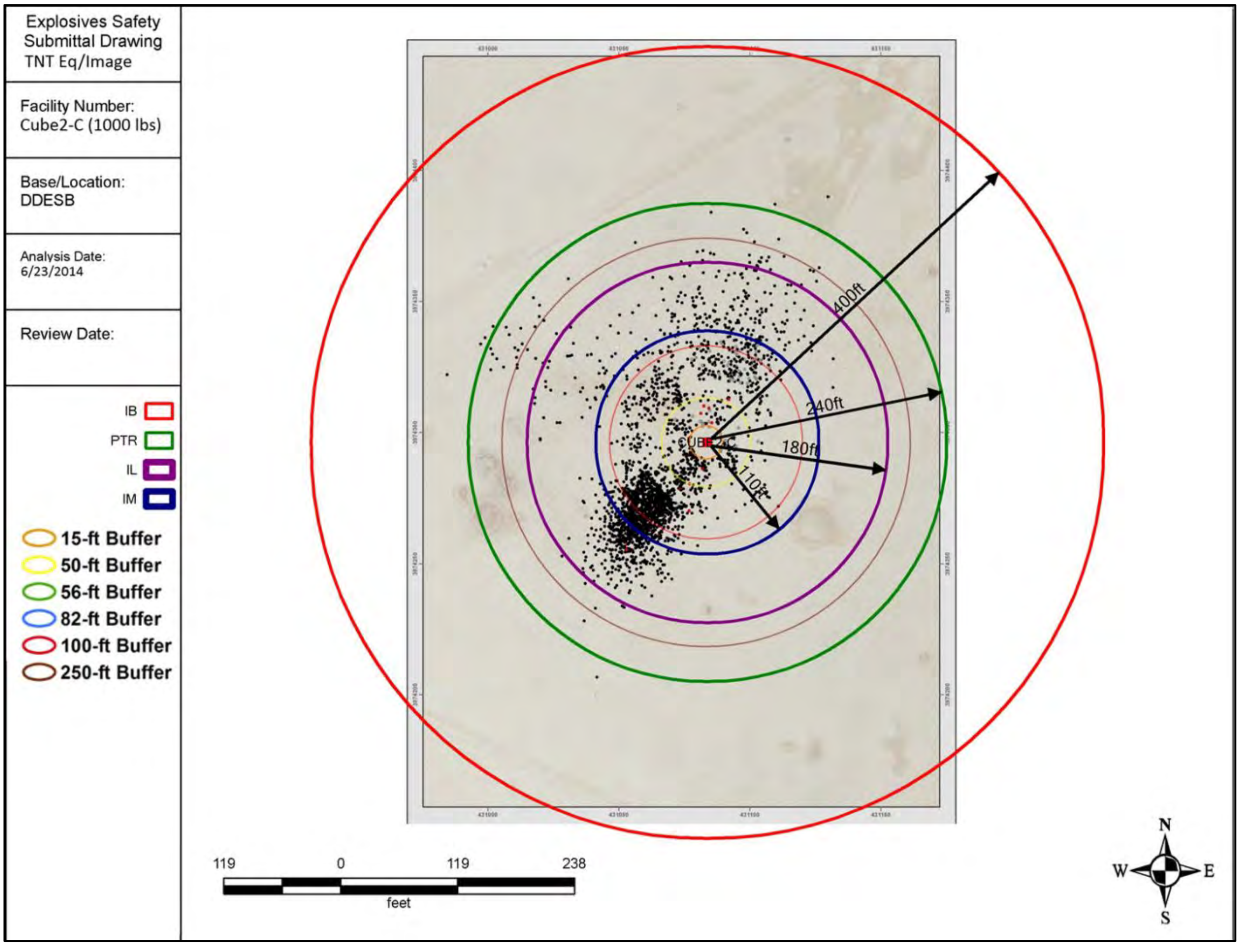

Figure VI-A-19 – ESS QD arcs for Scenario 3 Test 2 overlaid on debris collection map

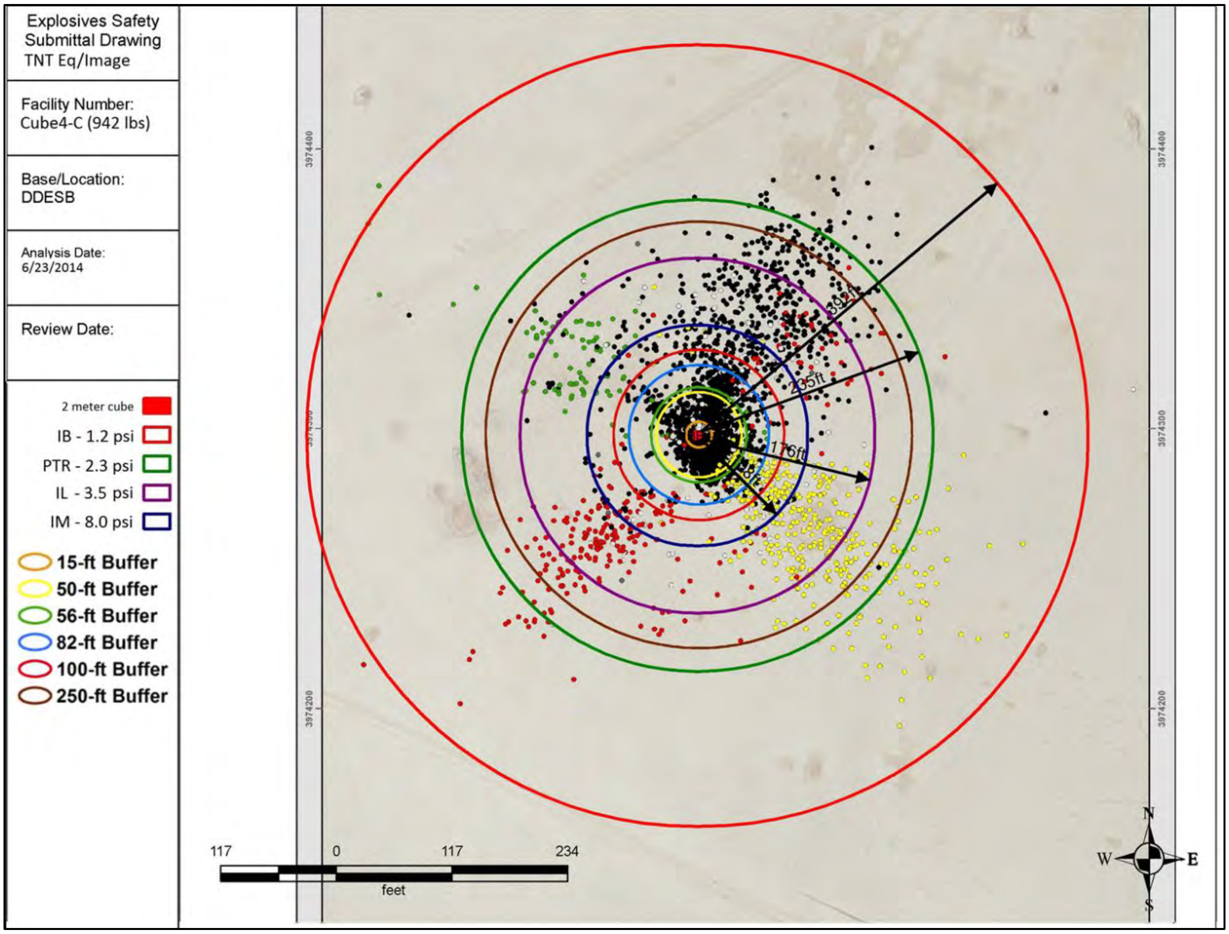

Figure VI-A-20 – ESS QD arcs for Scenario 3 Test 4 overlaid on debris collection map

2.4. ESS Conclusions

The ESS software was used to simulate the confined HD 1.3 test series. Each of the three analysis methods utilized did not produce accurate predictions of the explosives behavior or hazards. Modeling the event strictly as a HD 1.3 event (Scenario 1) did not account for the fragment hazards or the potential for detonation. Modeling the event as a true HD 1.1 event (Scenario 2) overestimated the range of the fragment hazard. The methodology of using an 85% TNT equivalency (Scenario 3) and showing only the HD 1.1 overpressure arcs also overestimates the combined hazards and does not reflect the fragment hazard.

3. SAFER Analysis

The process of simulating the test results into SAFER involved several steps. These steps included:

- Loading the facility and explosives information into a SAFER file
- Calculating results based on the DDESB TP-14 methodology
- Interpreting all of the results

SAFER is designed to consider the risk to people, but in this case only the blast effects information from SAFER was considered. The explosives effects terms selected for analysis were pressure, impulse, debris density, and maximum debris throw distance. These data will be compared to the test results where possible, but there was not sufficient time for the analysis to process all of the HD 1.3 test results.

In order to accurately and completely model the China Lake test scenario and to capture a complete data set for comparison, a series of 12 SAFER runs were completed for each of the three scenarios described in Section 1. The 12 SAFER runs are based on a range of varying PES-ES separation distances. As with the ESS analysis, the ultimate goal was to compare the SAFER results with Tests 2 and 4 from the confined HD 1.3 test series. Therefore, the input parameters were designed to match these tests. Test 2 used 1,176 lbs of HD 1.3 material and Test 4 used 1,108 lbs. Based on the debris throw distances and debris densities observed for Tests 2 and 4, a maximum range of 350 feet was used for effects modeling. An increment of 25 ft beginning at 75 ft from the donor was found to provide a sufficient data set.

The SAFER log file for each run was stored and analyzed specifically for the parameters of interest: pressure, impulse, max throw, and debris density. Pressure and impulse figures were determined from Step 6 of the log file under “Adjusted pressure due to PES (psi)” and “Adjusted impulse due to PES (psi-ms)” respectively. Debris density and max throw values were also calculated from the SAFER output log files.

The China Lake tests utilized a similar donor structure as the Klotz Group Kasun tests. The test donor structure had dimensions of 2m x 2m x 2m, however SAFER does not allow the user to specify donor structure dimensions. The PES type was chosen from the SAFER list as to most closely represent that of the donor structure used in the confined 1.3 tests - in this instance the SAFER PES was chosen as a small concrete structure. Similarly, user inputs which affect the blast consequences were chosen to closely resemble the test scenario and are shown in Table VI-A-9.

Table VI-A-9 – SAFER PES critical input

SAFER Data Requirement	Input
PES Building Category	Operating Building (Concrete structure)
PES Building Type	Small Concrete Building
Soil Type	Concrete
Hazard Division	1.3 or 1.1
Weapon Type	Bulk/Light Case
Weapon Description	Thin Skinned
Sited NEW	Varied
Expected NEW	Varied

SAFER user inputs which affect only probability of event and have no effect on effects/consequences were chosen arbitrarily and are shown in Table VI-A-10.

Table VI-A-10 - SAFER PES non-critical input

SAFER Data Requirement	Input
Operating Hours	8000
Activity Type	Assembly
Environmental Factors	None
Compatibility Group	D

Table VI-A-11 shows the ES user input options that were selected. These inputs should, as closely as possible, allow for the desired data to be captured enabling a full analysis of the blast consequences compared to the China Lake HD 1.3 tests.

Table VI-A-11 - SAFER ES inputs

SAFER Data Requirement	Input
Building Type	Open
Roof Type	N/A
Window Type	None
Percent Glass	0
Floor Area (sq. ft.)	100

The PES NEW for Tests 2 and 4 were considered and ES distance was varied according to the methodology described previously.

3.1. HD 1.3 Event

The HD 1.3 scenario is discussed first. The only mechanism SAFER outputs for HD 1.3 is the thermal hazard mechanism. For this mechanism, the calculated fireball radius could potentially be compared to observed results from the test series. The fireball radius is calculated using equation 176 of Reference VI-A-2.

For Test 2 with 1,176 lbs of HD 1.3 material inside of a concrete structure, the fireball radius is calculated to be 35.2 ft. For Test 4 with 1,108 lbs, the fireball radius is calculated to be 34.6 ft.

Overall, the HD 1.3 algorithms in SAFER do not produce detailed results that would be directly comparable. Without pressure, impulse, or debris calculations those parameters were not able to be compared against the confined HD 1.3 tests.

3.2. HD 1.1 Event

The second approach was to model the confined HD 1.3 tests using HD 1.1 in SAFER. Similarly, this method was not expected to produce accurate results in comparison to the results in China Lake, due to overly conservative energy derivations when compared to confined HD 1.3; i.e., all parameters of interest in the model predictions were expected to be significantly greater than those in the results for Tests 2 and 4.

The calculated maximum throw range for 1,176 lbs is 4,251 ft, and the calculated value for 1,108 lbs is 4,197 ft. These values are more than a factor of 10 greater than the observed maximum throw distance from the tests (approximately 350 ft). Figures VI-A-21 through VI-A-23 present the effect parameters calculated in SAFER.

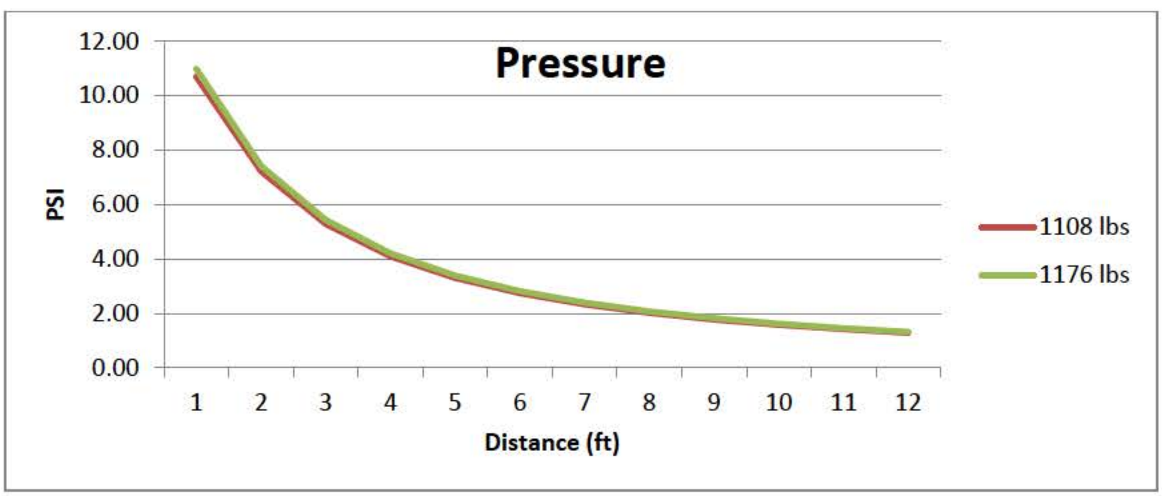

Figure VI-A-21 – SAFER Scenario 2 – Full HD 1.1 Pressure Results

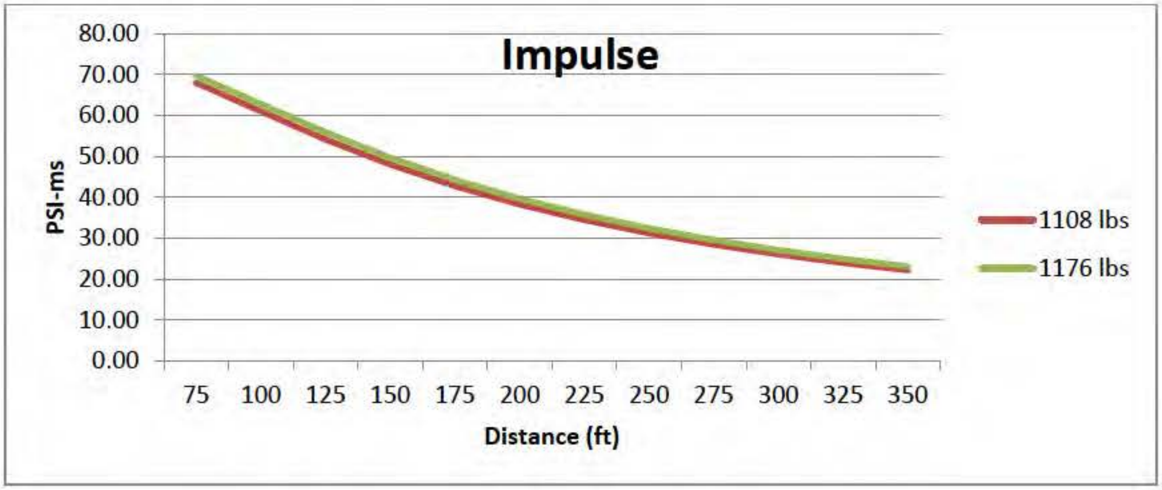

Figure VI-A-22 – SAFER Scenario 2 – Full HD 1.1 Impulse Results

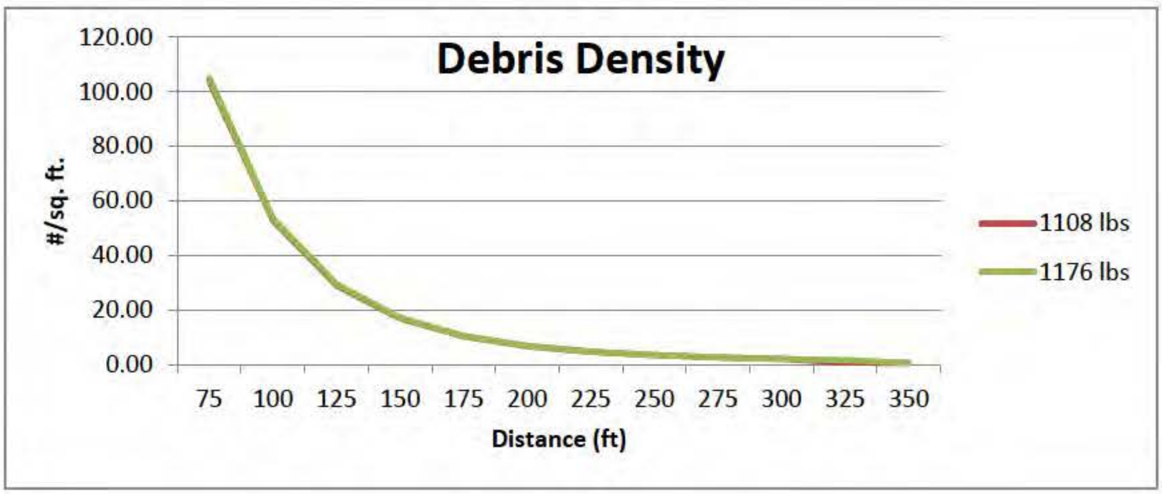

Figure VI-A-23 – SAFER Scenario 2 – Full HD 1.1 Debris Density Results

A direct comparison with measured values from the test series was not available at the time of the analysis but it is expected that the values calculated by SAFER for HD 1.1 material are much higher than those measured during the confined HD 1.3 tests.

3.3. Modified HD 1.1 Event

The third approach was to model the confined HD 1.3 tests using HD 1.1 in SAFER with TNT equivalence considered. With equivalencies chosen based on previous studies, this method was expected to yield the best results of the three approaches discussed in this document, though it is understood that confined HD 1.3 events cannot be directly modeled through a TNT equivalency due to the difficulty in matching the behavior for all the effects (overpressure, impulse, and

debris). It must also be noted that the TNT equivalence method cannot capture two key elements of the problem that the tests are designed to consider, namely vent-area and propellant burn rate. These parameters cannot be considered if only the NEW is taken into account.

Utilizing the 0.85 TNT equivalent value described in Section 1.1, SAFER was again used to predict the effects. However, it should be noted that while this is the best option of the three, the limitations of this study did not exhaust comparisons for all possible TNT equivalencies that could be used to match the test results; furthermore it is acknowledged that TNT equivalencies are not ideal for capturing the independent behavior of overpressure, impulse, and debris in the confined HD 1.3 events.

The calculated maximum throw range for 1,000 lbs is 4,106 ft, and the calculated value for 942 lbs is 4,053 ft. These values are still more than a factor of 10 greater than the observed maximum throw distance from the tests (approximately 350 ft). The TNT equivalency does dramatically reduce the calculated effects.

Figures VI-A-24 through VI-A-26 show the effect parameters derived from this method.

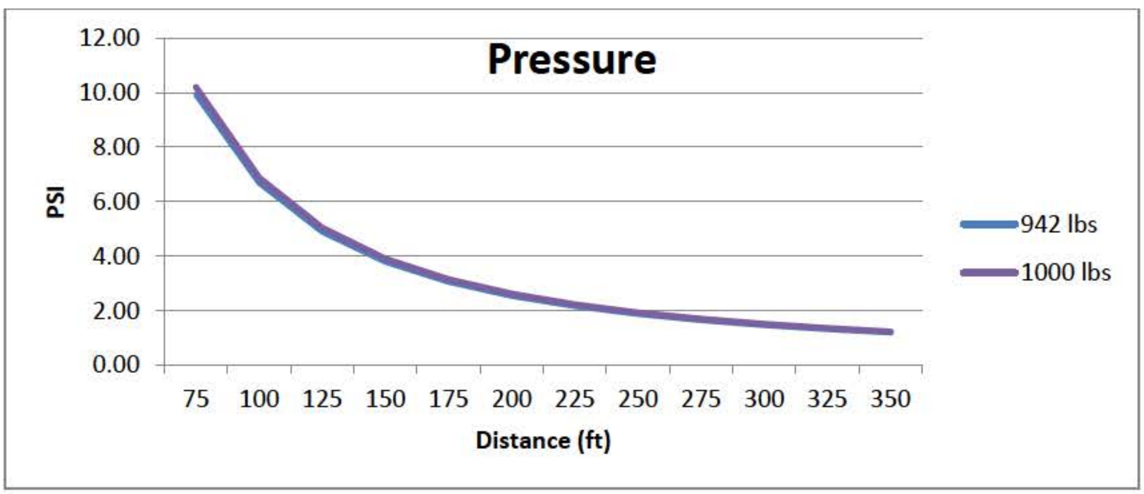

Figure VI-A-24 – SAFER Scenario 3 – Pressure with Equivalent NEW

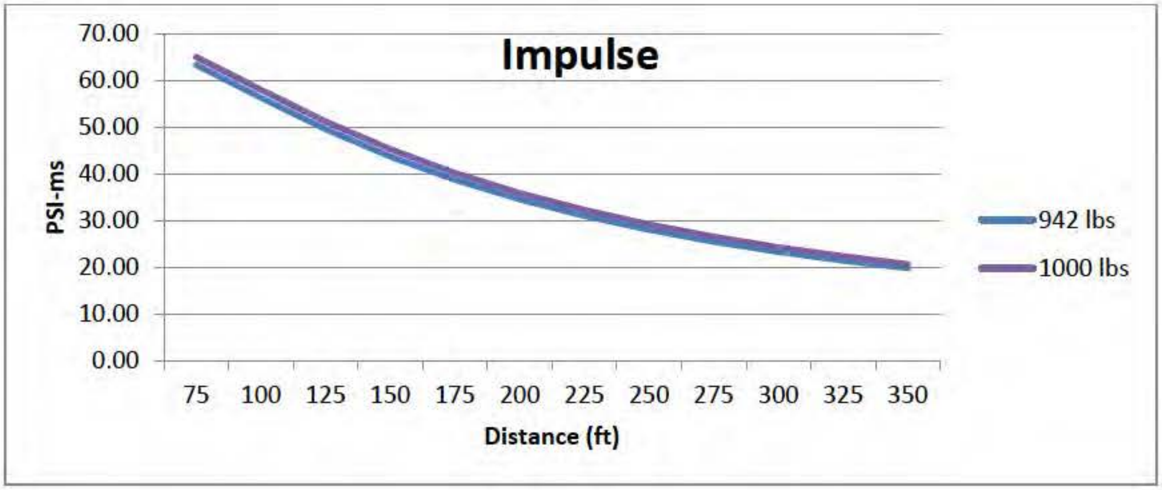

Figure VI-A-25 – SAFER Scenario 3 – Impulse with Equivalent NEW

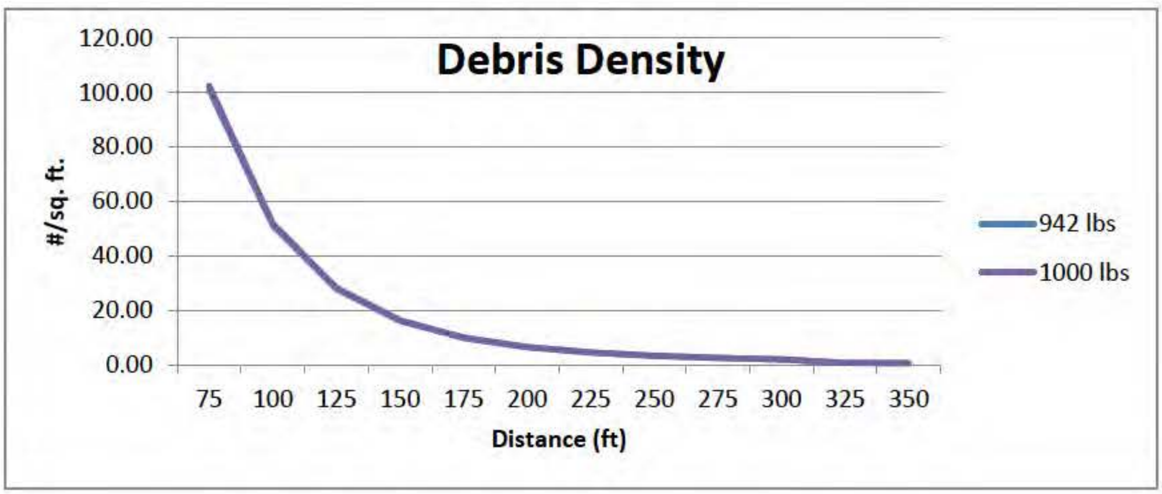

Figure VI-A-26 – SAFER Scenario 3 – Debris Density with Equivalent NEW

Debris density values were also tabulated for this scenario. Step 15 in the SAFER algorithm outputs values for arriving primary and secondary debris. The sum of each of the following was calculated to determine the total debris density for the respective NEW/distance combination. Table VI-A-12 shows the debris fragment categories.

The primary debris density, secondary debris density, and crater ejecta debris density were each summed for all 17 categories, for each bin. That value was input into the spreadsheet to give the value shown in the plot for each test run.

Table VI-A-12 - Debris categories

Primary Debris Density Calculations, bins 1-10 (#/ft^2)
Vertical primary fragments
Horizontal side-impact primary fragments
Horizontal fly-through primary fragments
Secondary Fragment Debris Density Calculations, bins 1-10 (#/ft^2)
Vertical Steel fragments from roof
Vertical concrete fragments from roof
Horizontal side-impact steel fragments from the front/side/rear
Horizontal fly-through steel fragments from the front/side/rear
Horizontal side-impact concrete fragments from the front/side/rear
Horizontal fly-through concrete fragments from the front/side/rear
Crater Ejecta Debris Density Calculations, bins 1-10 (#/ft^2)
Crater ejecta vertical fragments

Table VI-A-5 shows an example debris density calculation: NEW 1,000 lbs @ 250'.

Table VI-A-13 - Debris Density Calculation Example

	Bin 1	Bin 2	Bin 3	Bin 4	Bin 5	Bin 6	Bin 7	Bin 8	Bin 9	Bin 10	∑
Primary Fragments											
Vertical Primary Fragments	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Horizontal Side Impact	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Horizontal Fly Through	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.003	0.000	0.005
Secondary Fragments											
Vertical Steel - Roof	0.000	0.000	0.000	0.000	0.000	0.001	0.003	0.010	0.047	0.000	0.061
Vertical Concrete - Roof	0.000	0.000	0.001	0.001	0.002	0.007	0.022	0.064	0.173	0.703	0.972
Horizontal Side Impact Steel - Front	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.003	0.000	0.003
Horizontal Side Impact Steel - Side	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.005	0.000	0.007
Horizontal Side Impact Steel - Rear	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.003	0.000	0.003
Horizontal Fly Through Steel - Front	0.000	0.000	0.001	0.001	0.001	0.002	0.004	0.007	0.017	0.000	0.033
Horizontal Fly Through Steel - Side	0.000	0.001	0.001	0.001	0.002	0.005	0.008	0.014	0.034	0.000	0.067
Horizontal Fly Through Steel - Rear	0.000	0.000	0.001	0.001	0.001	0.002	0.004	0.007	0.017	0.000	0.033
Horizontal Side Impact Concrete - Front	0.000	0.000	0.000	0.000	0.001	0.003	0.008	0.023	0.058	0.218	0.311
Horizontal Side Impact Concrete - Side	0.000	0.000	0.000	0.001	0.002	0.005	0.016	0.046	0.117	0.435	0.622
Horizontal Side Impact Concrete - Rear	0.000	0.000	0.000	0.000	0.001	0.003	0.008	0.023	0.058	0.218	0.311
Horizontal Fly Through Concrete - Front	0.001	0.003	0.010	0.012	0.013	0.021	0.031	0.038	0.037	0.030	0.197
Horizontal Fly Through Concrete - Side	0.002	0.007	0.021	0.024	0.026	0.042	0.062	0.076	0.073	0.061	0.394
Horizontal Fly Through Concrete - Rear	0.001	0.003	0.010	0.012	0.013	0.021	0.031	0.038	0.037	0.030	0.197
Crater Ejecta Fragments											
Vertical Fragments	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total Debris Density											3.316

A direct comparison with measured values from the test series was not available at the time of the analysis but it is expected that even these reduced values calculated by SAFER for a TNT equivalent quantity of HD 1.1 material are higher than those measured during the confined HD 1.3 tests. The values calculated in Scenario 3 are only slightly smaller than the values calculated in Scenario 2 for the full HD 1.1 quantity.

3.4. SAFER Conclusions

The SAFER software was used to simulate the confined HD 1.3 test series. Each of the three analysis methods utilized did not produce accurate predictions of the explosives behavior or hazards seen in the confined HD 1.3 tests. Modeling the event strictly as a HD 1.3 event did not account for the overpressure or debris hazards. Modeling the event as a true HD 1.1 event is expected to overestimate the consequences. The TNT equivalency methodology provides results that are expected to be slightly closer to the results of the HD 1.3 tests, but still over-conservative for the overpressure, impulse, and debris hazard of a confined HD 1.3 event.

4. Conclusions

The DDESB-approved software tools, ESS and SAFER, play important roles in analyzing hazards. However, they have been designed to address well-documented QD and QRA scenarios. The confined HD 1.3 test scenarios present a situation that cannot be addressed by these tools in their current form.

5. References

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VI-A-2. Approved Methods and Algorithms for DoD Risk-Based Explosives Siting, DDESB Technical Paper (TP) 14, Revision 4, July 2009.

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VI-A-4. "DOD Ammunition and Explosives Safety Standards," DOD 6055.09-M, DOD Explosives Safety Board, February 2008.

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VI-A-6. Swisdak, M. M., Maximum TNT Equivalence of Naval Propellants, Minutes of the 21st DoD Explosives Safety Seminar, 28-30 August 1984.

VI-A-7. Swisdak, M. M. and Rye, K. W., Hazard Division 1.2 Tests-Instrumentation Results and Interpretation, NSWCDD/TR-93/218, December 1993.

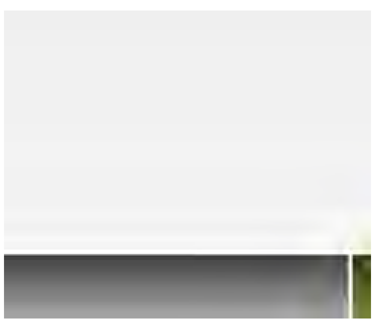
Comparison of Kasun III to US Confined HD 1.3 Tests

Klotz Group Spring 2014 Meeting, April 2014

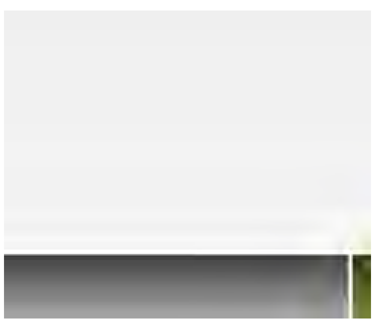
Developed by: APT-Research, Inc.

- Kasun III test series
  - HD 1.1 tests (bare charges and cased charges) using the Kasun PES structure
  - Debris collected for rear wall and one side wall
- Confined HD 1.3 test series
  - HD 1.3 tests focusing on choked flow using the Kasun PES structure
  - Test 2 – single perforated pellet
  - Test 4 – larger pellet with multiple perforations – longer burn
  - Debris collected for all walls
  - These tests were affected slightly by the PES door connection details
- Data presented in this comparison
  - Mass distribution by bin
  - Cumulative mass distribution
  - Horizontal launch angles

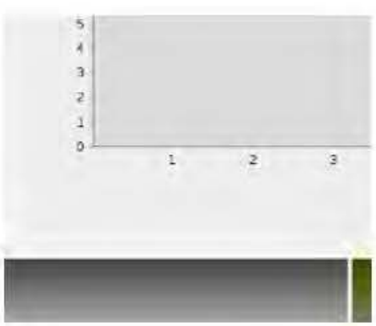
- Kasun III test series (all HD 1.1)
  - Test 6 – 6.9 kg bare charge
  - Test 7 – 110 kg bare charge
  - Test 8 – 6.9 kg cased charge
  - Test 9 – 27.6 kg cased charge
  - Test 10 – 110 kg cased charge
- Confined HD 1.3 test series
  - Test 2 – 533 kg choked flow
  - Test 4 – 503 kg choked flow



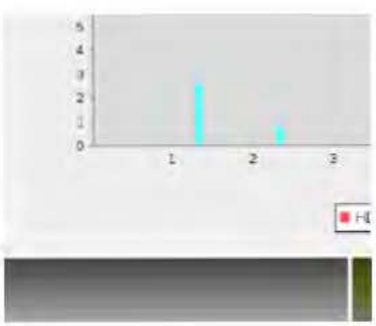
Comparison of Mass Distribution by Bin



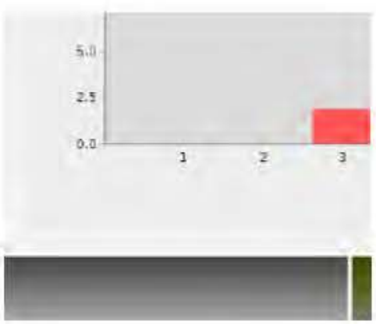
- Confined HD 1.3 Test 2



- Comparison to Kasun III data

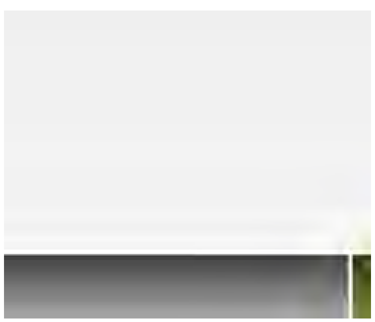


- Confined HD 1.3 Test 4



- Comparison to Kasun III data

Comparison of Cumulative Mass Distribution

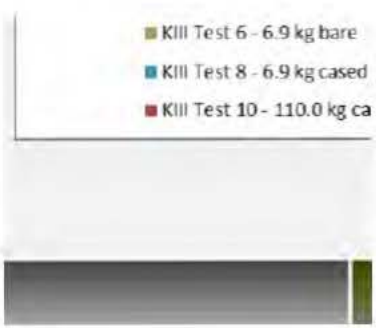


Comparison of Horizontal Debris Launch Angles

- Kasun III test series
  - Collected for the rear wall and one side wall in 10 degree sectors
  - Five sectors collected for each wall (-20, -10, 0, 10, and 20 degrees)
- Confined HD 1.3 test series
  - Data collected in all directions with GPS coordinates
  - Data processed to be equivalent to Kasun format
  - Data for two side walls have been averaged
  - Data for Test 2 is heavily influenced by roof debris
  - Data for Test 4 represents only the walls
- Data presented in this comparison
  - Data is shown as normalized debris counts
  - Kasun format accounts for only a 50-degree angle for each wall, therefore normalized data does not account for all debris coming from the wall

- Rear wall data

- Side wall data



A-P-T Research, Inc.

Development of Kasun PES Model

Presented to Kevin Ford

November 3, 2013

APT Research

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Overview

- Introduction
- Kasun model parameters
  - General model parameters
  - Adjusted weight parameters (Overpressure)
  - Mass distribution parameters
- Comparison to test data

Introduction

- APT was tasked to develop an operational model of the Kasun test structure within IMESAFR
- The model has been developed based on the HD1.1 testing from the Kasun II and III test series
- The model is based only on the loading densities from these HD 1.1 test series
- The intent is to match the results of the HD 1.1 Kasun trials and then extend this model to confined HD 1.3 scenarios in the future
- The Kasun PES model that has been developed has not been compared to the confined HD 1.3 test data

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Introduction

- What this model IS intended for (so far):
  - A comparison to the existing Small Concrete PES for HD 1.1 events
  - A comparison to the Kasun II and III HD 1.1 test data for the specific loading densities of these Kasun test programs
- What this model IS NOT intended for (yet):
  - Any comparison to the confined HD 1.3 tests performed at China Lake
  - A comparison to other HD 1.1 events outside of the range of loading densities tested in the Kasun II and III series

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General Model Parameters

Kasun PES Model Parameters

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- The Small Reinforced Concrete PES was used as the baseline model
  - Parameters were updated to match dimensions of the Kasun structure
  - Parameters were further updated to match test results from the Kasun trials
- Only concrete fragments from the Kasun test have been considered
- The initial breakout (Y_0) and total destruction (Y_{100}) values were based on engineering judgment from the limited photos
  - Initial breakout values for each component are the same at 3.0 lbs
  - Total destruction values are 25.0 lbs for the roof and 20.0 lbs for the walls

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Structural Mass

- Structural properties were based on structural drawings for the Kasun structure used for the HD 1.3 tests
- The front/door wall was not considered different in this revision of the model
- Assuming a 2m x 2m x 0.15m (7' x 7' x 6") wall and half of each corner:
  - Total mass of each side/rear wall or the roof = 3,953 lbs (1,793 kg)
  - %mass concrete = 88%
  - %mass steel = 12%
- The total theoretical mass of the structure (without the floor) that could be thrown as debris is 19,765 lbs (8,965 kg) of which 17,393 lbs (7,889 kg) is concrete that can be compared to the test data

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Kasun PES Model Parameters

- The initial velocity equation coefficients were based on the average velocities obtained from video analysis
  - The velocity coefficients were chosen to best match the data from all tests

Component	a_{iv}	exp_{iv}
Roof	410	0.38
All walls	800	0.53

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Kasun PES Model Parameters

- Maximum throw parameters were based on collected fragment data
  - Knowing the maximum throw for each test and the initial velocity based on the previously computed IV equation, coefficients were chosen to best fit the test data
- Maximum throw limits were set to approximate the furthest fragment distance found in the tests

Max throw equation coefficients	
SP	300
e1	0.29
e2	0.08
CP	140

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Adjusted Weight Parameters

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Current SAFER/IMESAFR Model

- Kasun structure was initially based on the "Small Concrete" PES model
- The following table presents the current Adjusted Weight curve fit coefficients for the Small Concrete Model

Z ($ft/lb^{1/3}$)	Adjusted Weight, W_a (lbs)	A	B	C	D	E	F
> 140	$W_a = 0.85 * W_1$						
1.15 – 140	Equation	-4.18694	2.28941	-0.16247	-0.07102	-0.00045	0.00187
< 1.15	$W_a = 0.02 * W_1$						

Equation: $W_a = W_1 * \exp\{A + B*[\ln(Z)] + C*[\ln(Z)]^2 + D*[\ln(Z)]^3 + E*[\ln(Z)]^4 + F*[\ln(Z)]^5\}$

Available Kasun Airblast Data

- Kasun II
  - Test 1
    - 20 kg bare
  - Test 2
    - 20 kg bare
  - Test 3
    - 80 kg bare
  - Test 4
    - 240 kg bare
  - Test 5
    - 160 kg bare
- Kasun III
  - Test 7
    - 110 kg bare
  - Test 10
    - 110.4 kg projectiles

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Proposed Kasun Model

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- Based on Kasun airblast data, new Adjusted Weight curve fit coefficients have been determined

Z ($ft/lb^{1/3}$)	Adjusted Weight, W_a (lbs)	A	B	C	D	E	F
> 60 3.5 – 60 < 3.5	$W_a = 0.90 * W_1$ Equation $W_a = 1.05 * W_1$	2.2903	-3.0919	1.3268	-0.25247	0.019065	0

Equation: $W_a = W_1 * \exp\{A + B*[\ln(Z)] + C*[\ln(Z)]^2 + D*[\ln(Z)]^3 + E*[\ln(Z)]^4 + F*[\ln(Z)]^5\}$

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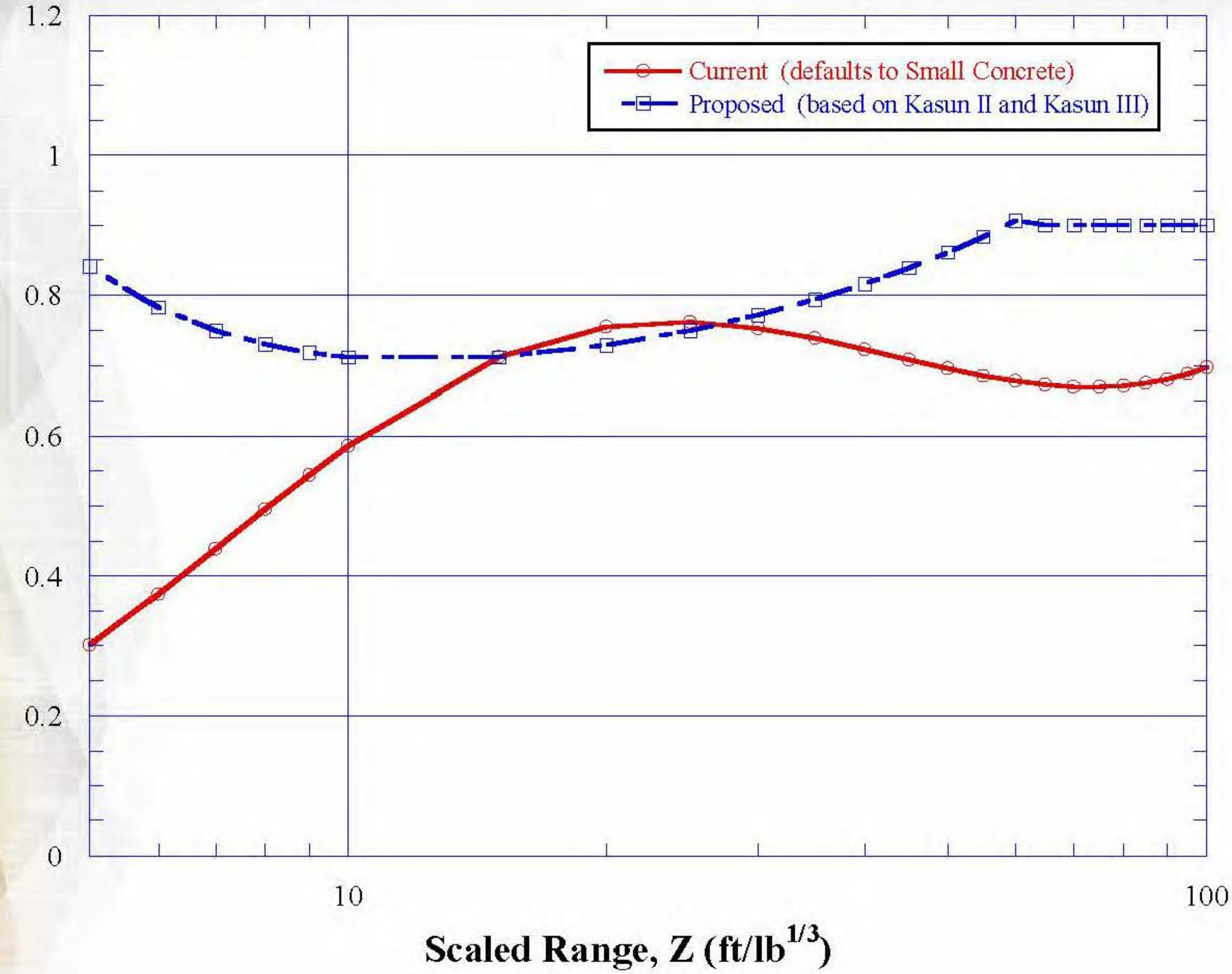
Adjusted Weight Comparison



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Mass Distribution Parameters

Kasun Mass Distribution

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- The rebar spacing is approximately 4” compared to 16” spacing for the SciPan structure
- The average fragment size is much smaller than the SciPan test data
- Debris smaller than 50 grams was not collected
- The idea that many of the fragments were below the minimum collection size (bin 10) is verified by the relatively low amounts of mass collected in the debris recovery

Kasun Mass Distribution

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- Mass distributions were generated based on the recorded debris collection results
- No debris were recorded within a 20 meter radius of the test
- The data were collected over a 145 degree sector (not quite 2 full walls)
- It is assumed that no debris larger than 50 grams were missed during collection
- These collected data were averaged and extrapolated to represent the entire structure
- These factors combined resulted in a significant amount of mass being accounted for in bins 9 and 10 due to conservation of mass

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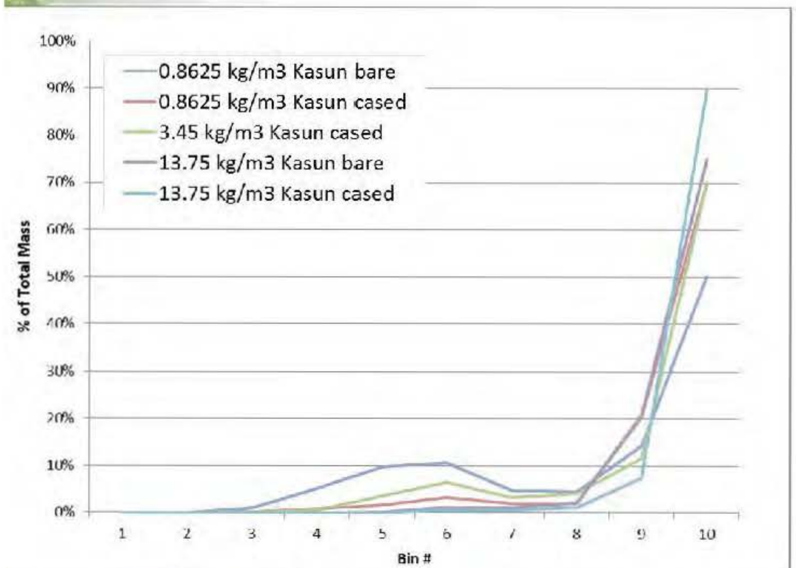
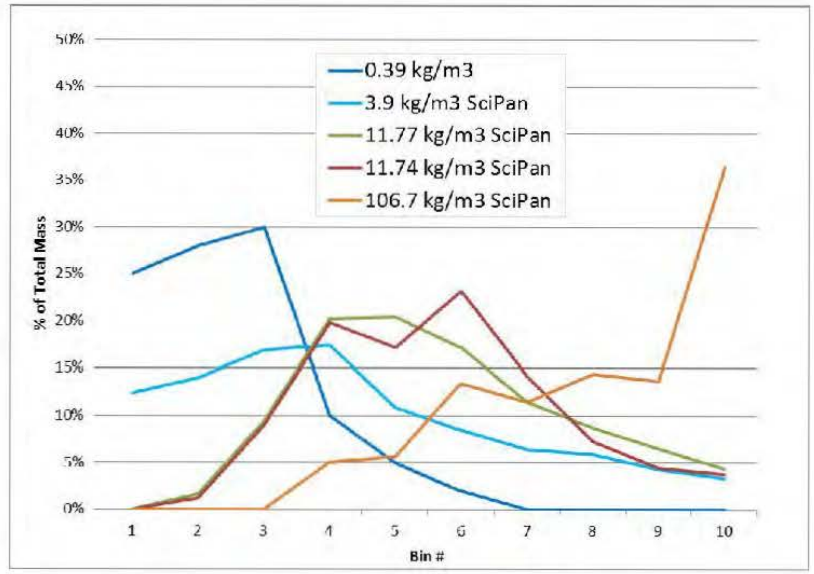
Kasun and SciPan Mass Distributions





- The Kasun data are consistently skewed to the smaller bins, even at lower loading densities
- This could be due to the rebar quantity and spacing

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Nominal Mass Distribution

- The nominal mass distribution is based off of the Kasun III Test 9 data.
- Test 9 was selected because it was the central loading density value for the five tests analyzed
- Properties of the Test 9 data
  - Loading density = 3.45 kg/m^3
  - Cased charge

Bin #	1	2	3	4	5	6	7	8	9	10
%Mass	0.0%	0.0%	0.1%	0.5%	3.7%	6.5%	3.4%	4.1%	11.7%	70.0%

- Large amount of mass is found in Bin 10 based on breakup assumptions discussed earlier
- This nominal distribution is used for both the roof and the walls

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Kasun Dynamic Distribution

- Nominal distribution will be at 3.45 kg/m^3 (cased)
- Increasing loading density will include 3.45 and 13.75 kg/m^3 from Kasun data (all walls are 0.15m = 5.9")
- Decreasing loading density will include 3.45 and 0.8625 kg/m^3 from Kasun data
- The dynamic model is tuned to the test data to obtain reasonably good agreement with data points at other loading densities
- Separate dynamic distributions have been created for the roof and wall to better capture the behavior at the low loading density

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Comparison to Test Data

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Kasun PES Model Parameters

- The fragment probability density distribution was adjusted to approximate the test data
  - A plot was generated for each 10 degree sector of the test data
  - Each plot was examined in order to determine how well the model fit the data
- Plots were created using two scales to better represent different characteristics
  - linear scale for examining how well the location of the peak densities match
  - semi-log plot for looking at the "tail" of the distribution (i.e., the very small densities at ranges of interest)

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Kasun PES Model Parameters

- Plot colors
  - The red line is the new Kasun model
  - The blue line is the previous Small Concrete model
  - The green line is the collected test data
- The new Kasun model (red line) should be a better match to the test data due to the updated component (wall and roof) masses
- Conservation of mass is still assumed, however all pieces from Bin 10 and 95% of pieces from Bin 9 have been removed to properly compare with the 50 gram lower limit on the debris collection

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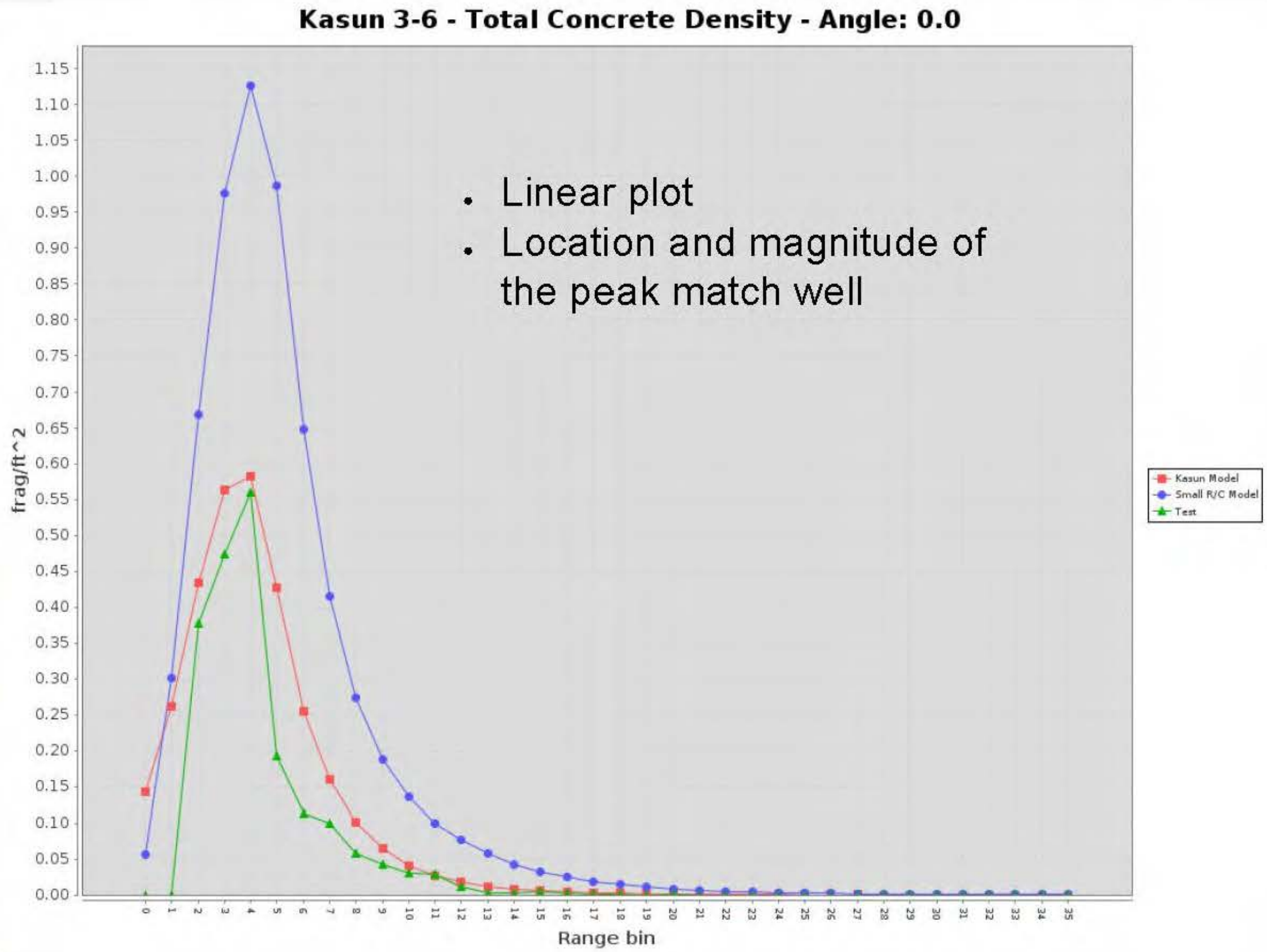
Kasun PES Model Comparison



- Linear plot
- Location and magnitude of the peak match well

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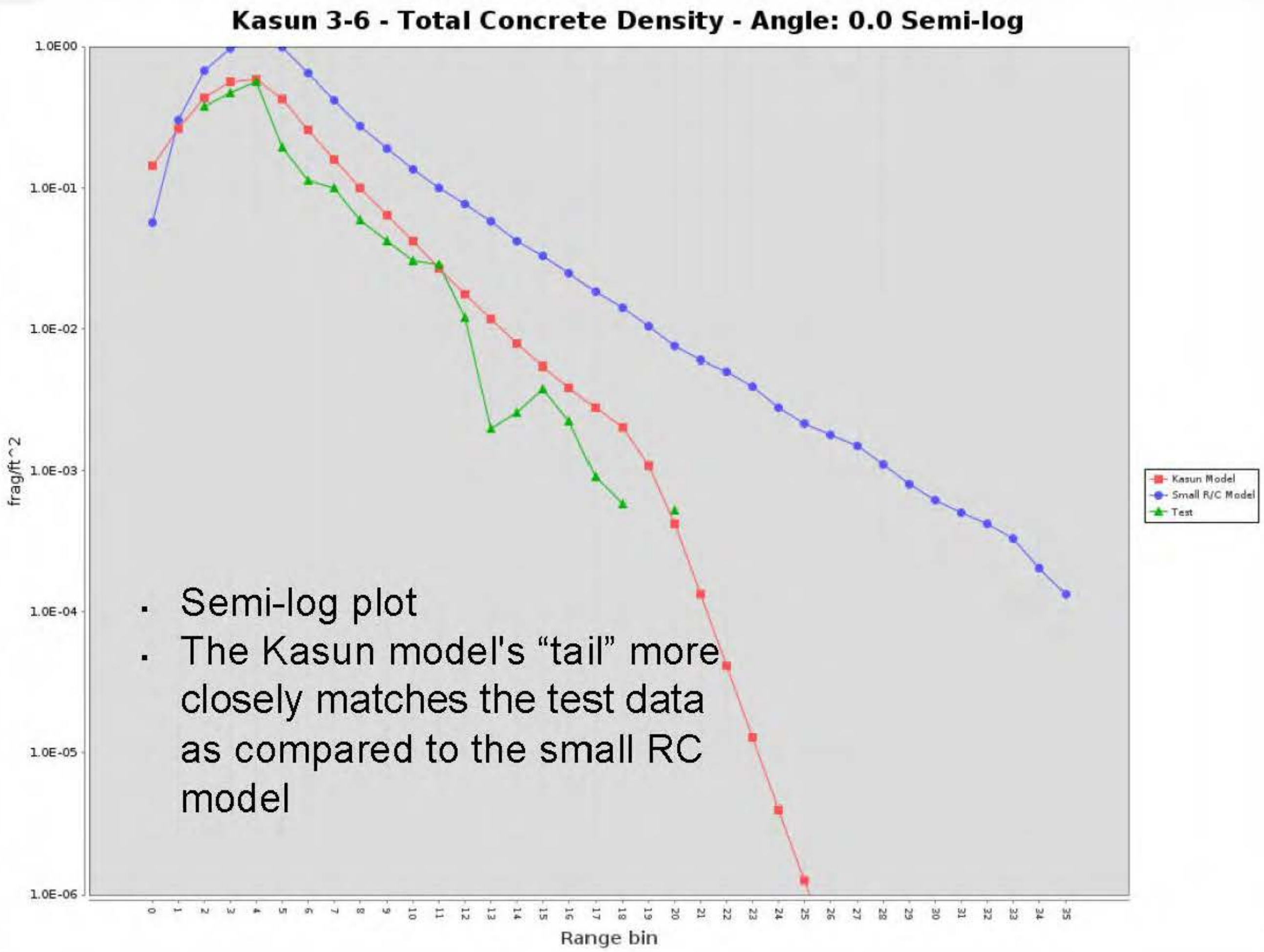
Kasun PES Model Comparison



- Semi-log plot
- The Kasun model's "tail" more closely matches the test data as compared to the small RC model

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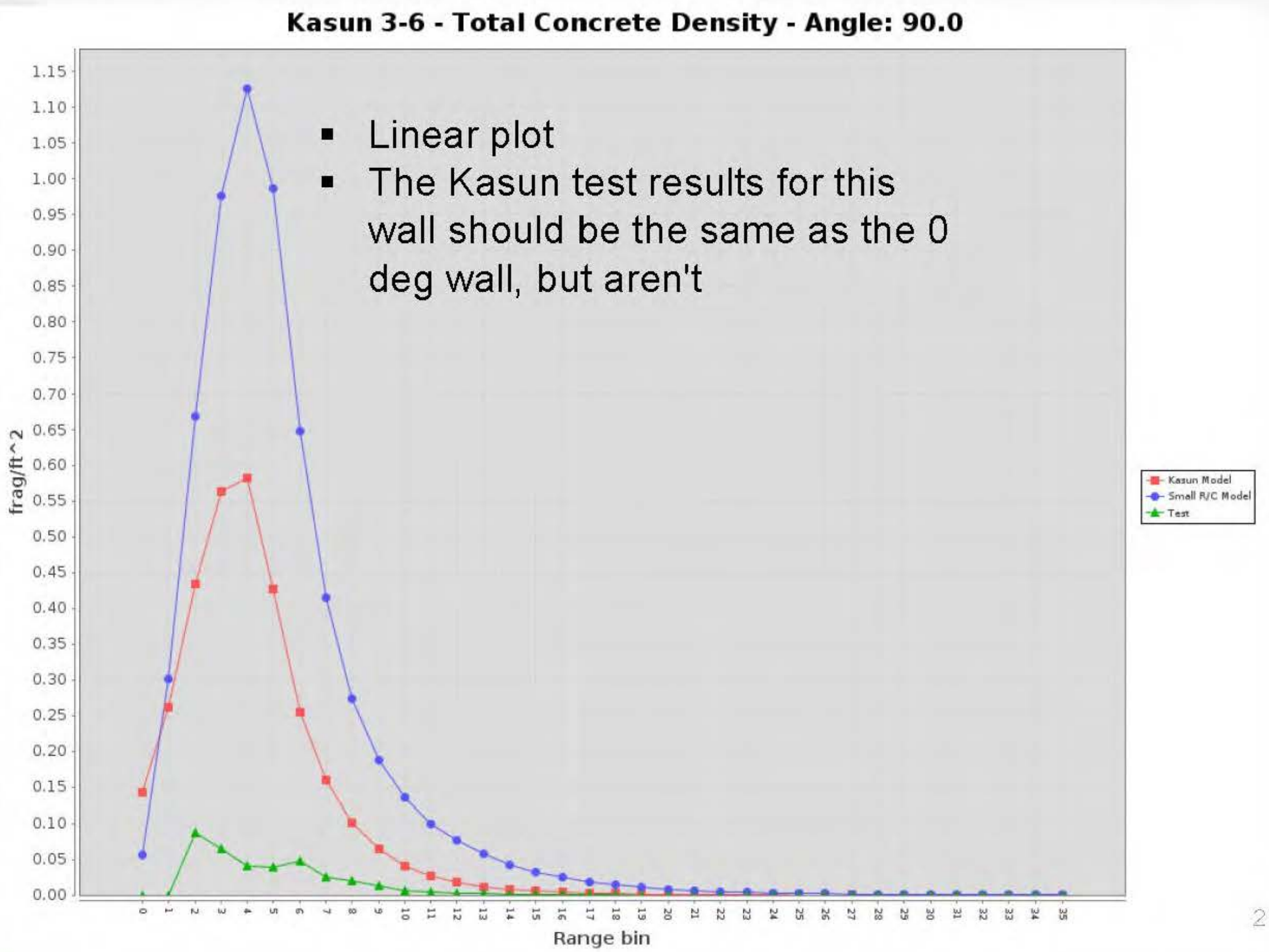
Kasun PES Model Comparison



- Linear plot
- The Kasun test results for this wall should be the same as the 0 deg wall, but aren't

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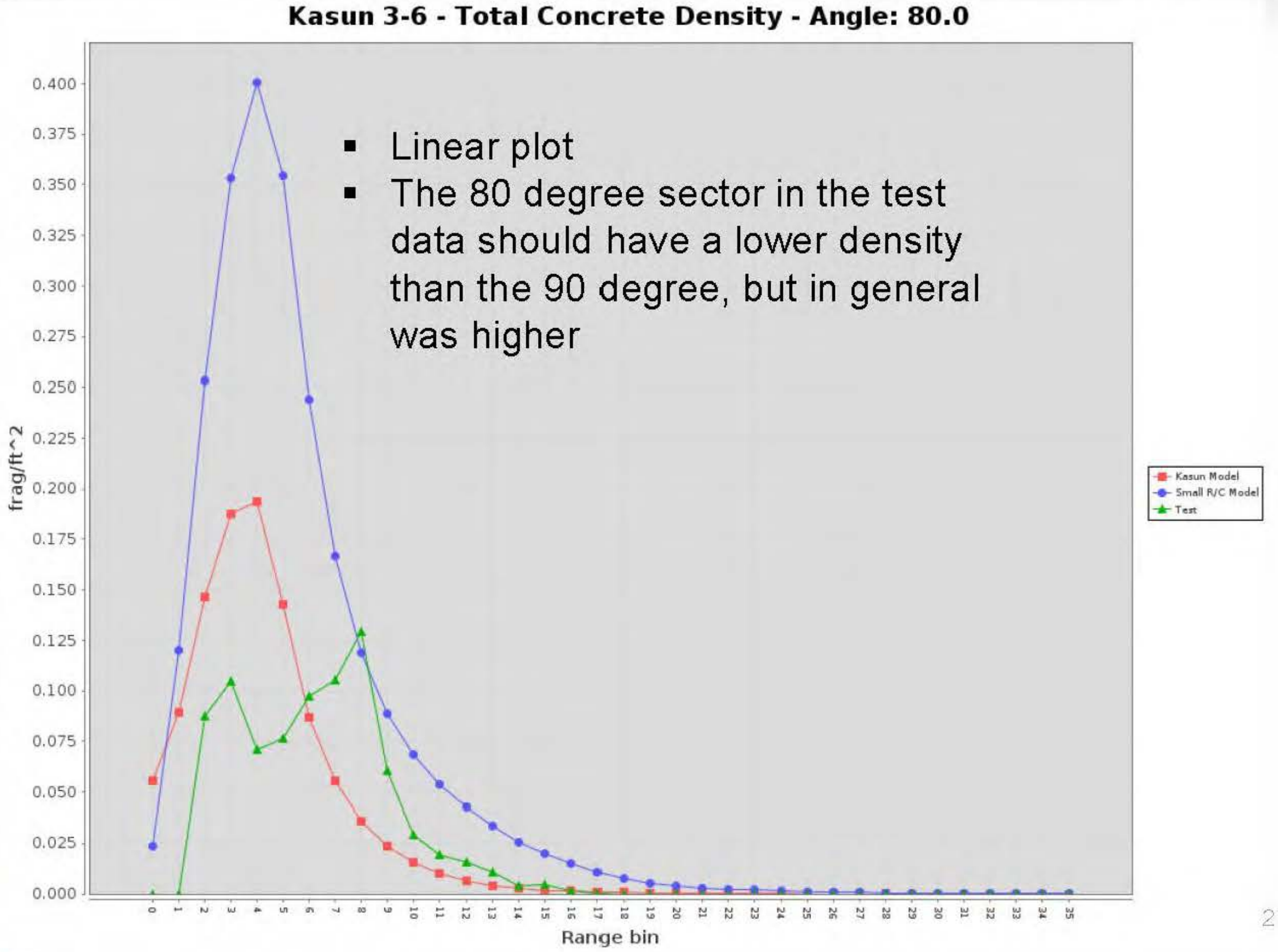
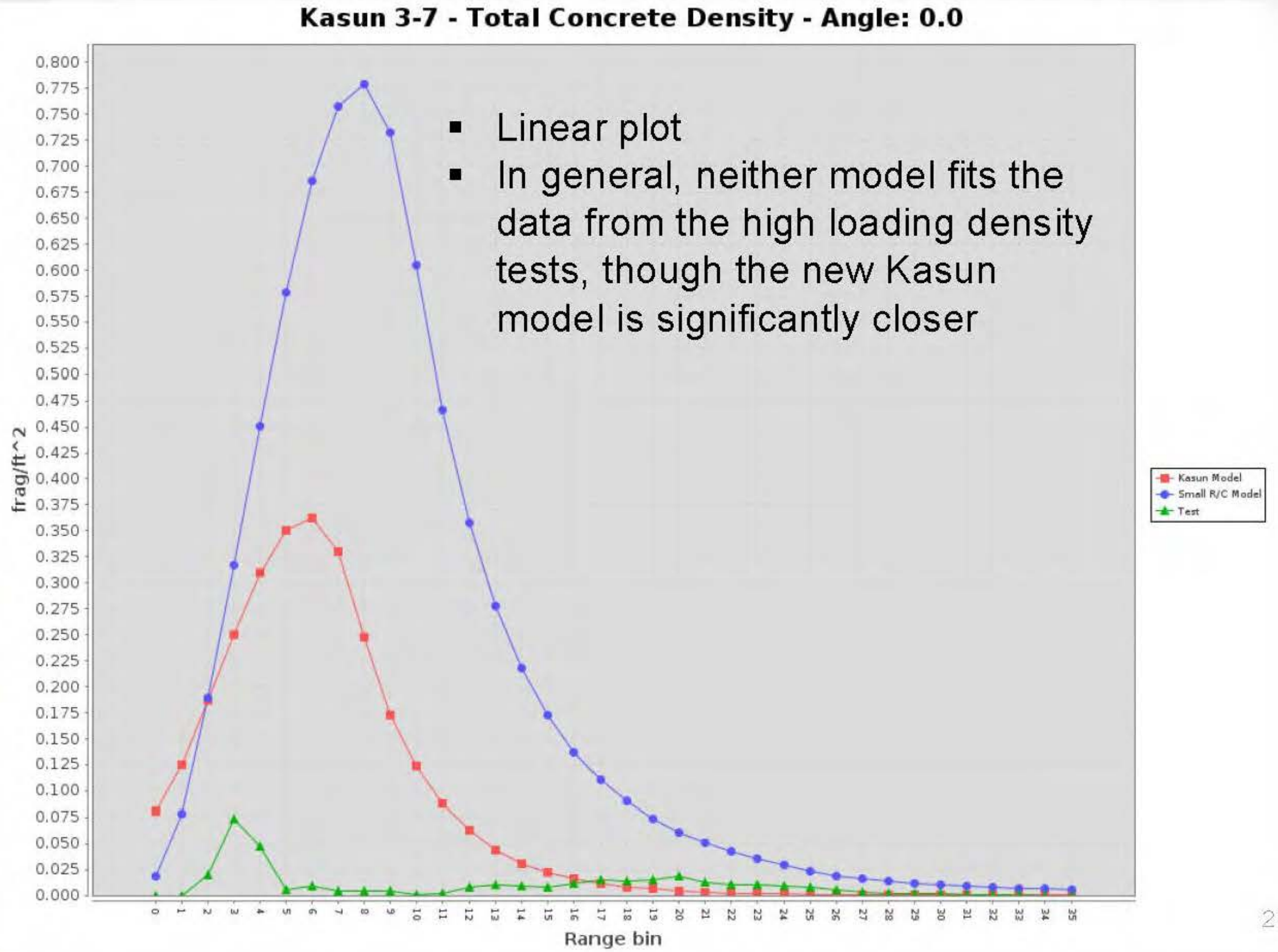
Kasun PES Model Comparison



- Linear plot
- The 80 degree sector in the test data should have a lower density than the 90 degree, but in general was higher

Kasun PES Model Comparison



- Linear plot
- In general, neither model fits the data from the high loading density tests, though the new Kasun model is significantly closer

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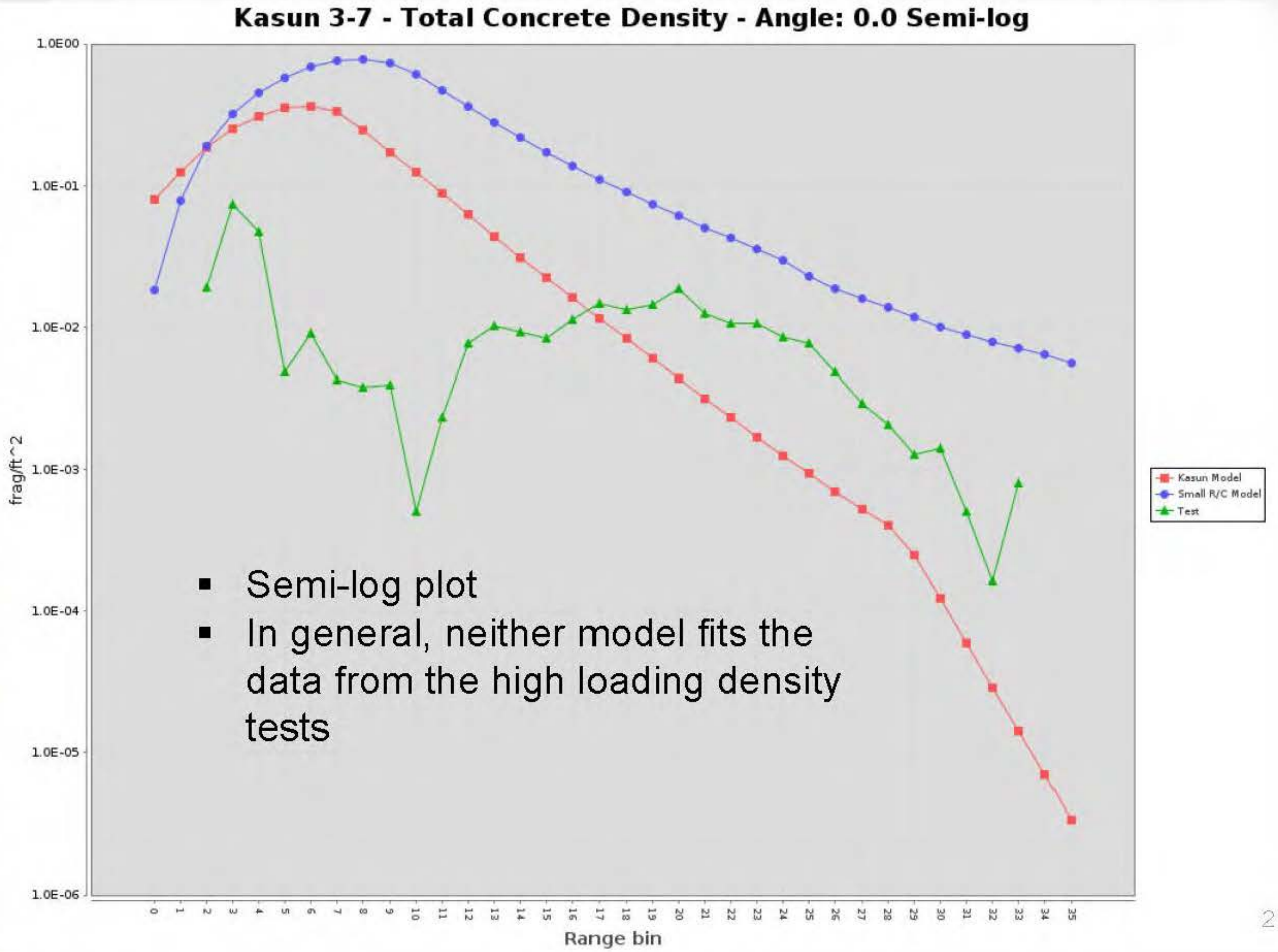
Kasun PES Model Comparison



- Semi-log plot
- In general, neither model fits the data from the high loading density tests

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Kasun PES Model Comparison

- Contour plots were generated to provide a quick comparison between the Kasun and Small Reinforced Concrete models
- Each image represents a 3000 ft x 3000 ft grid, with each pixel being 5 ft x 5 ft
- Debris density values are presented by color

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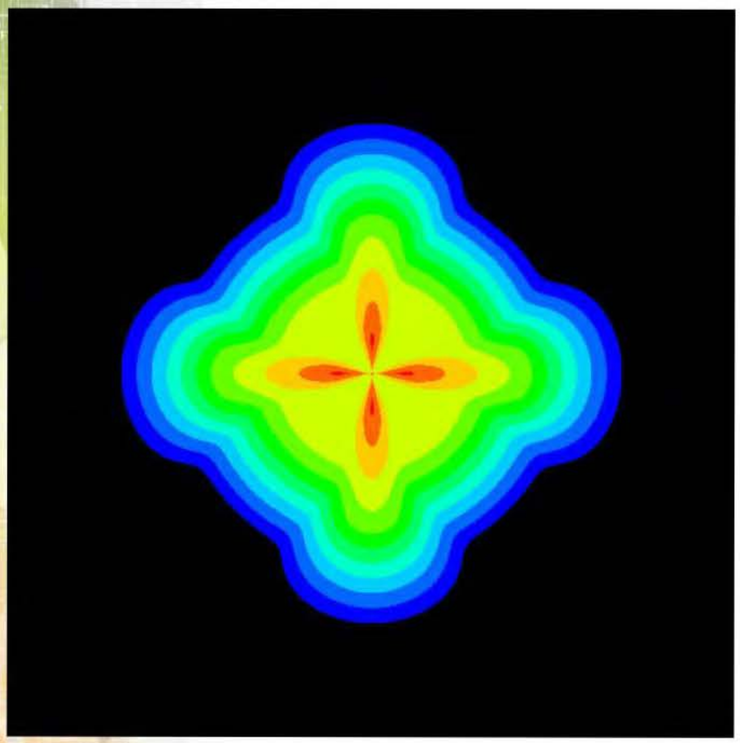
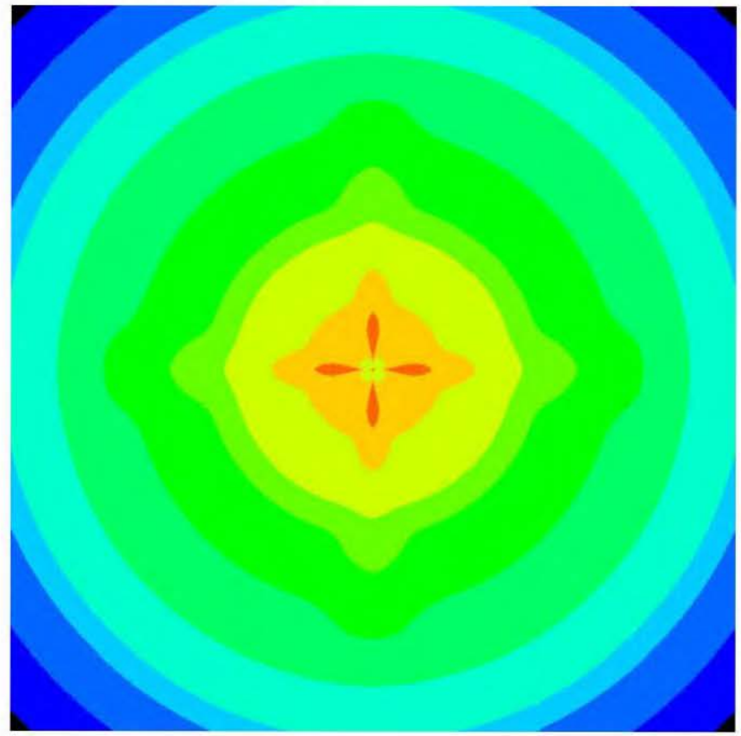
Kasun PES Model Comparison

Test 8 – 6.9 kg (15.2119 lbs)

Kasun Model



Small RC Model



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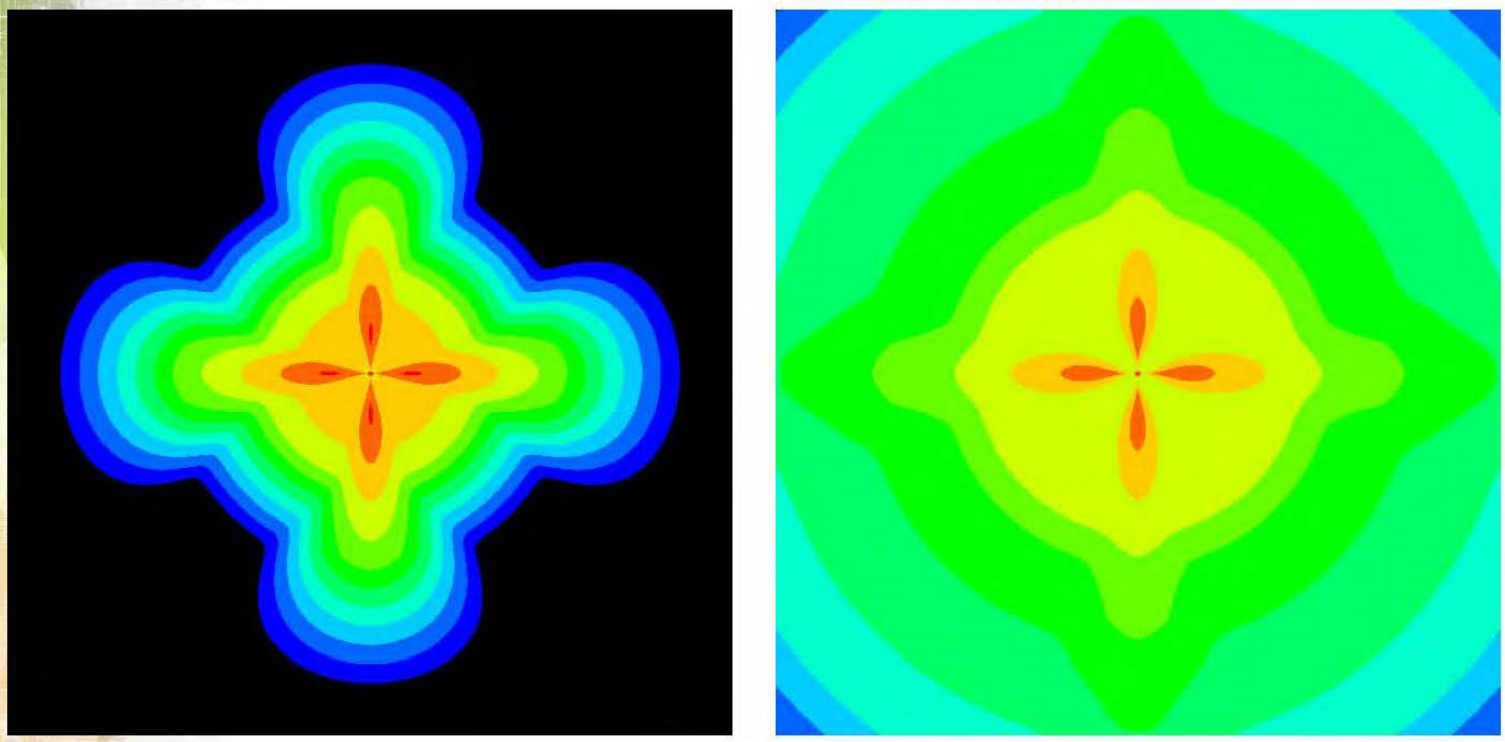
Kasun PES Model Comparison

Test 9 – 27.6 kg (60.8476 lbs)

Kasun Model | Small RC Model



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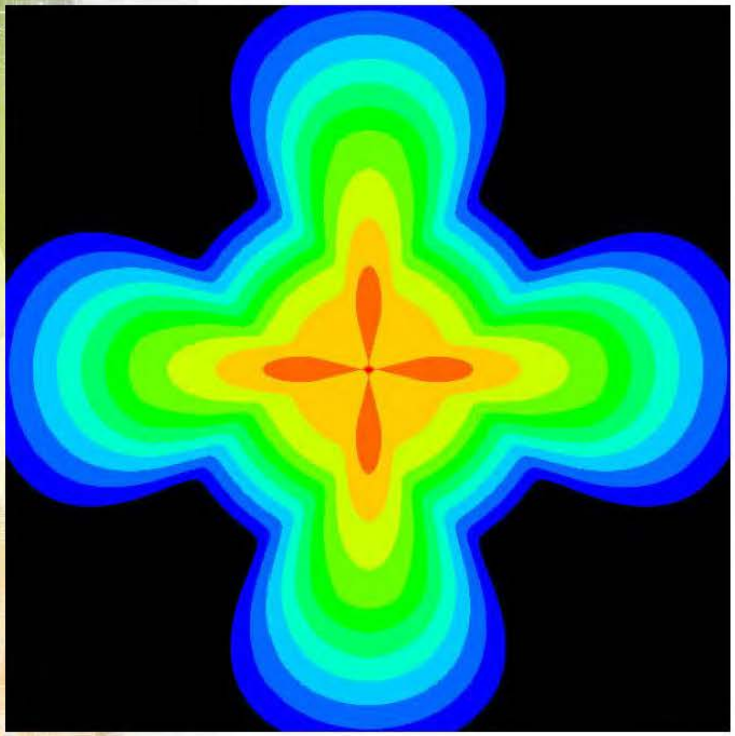
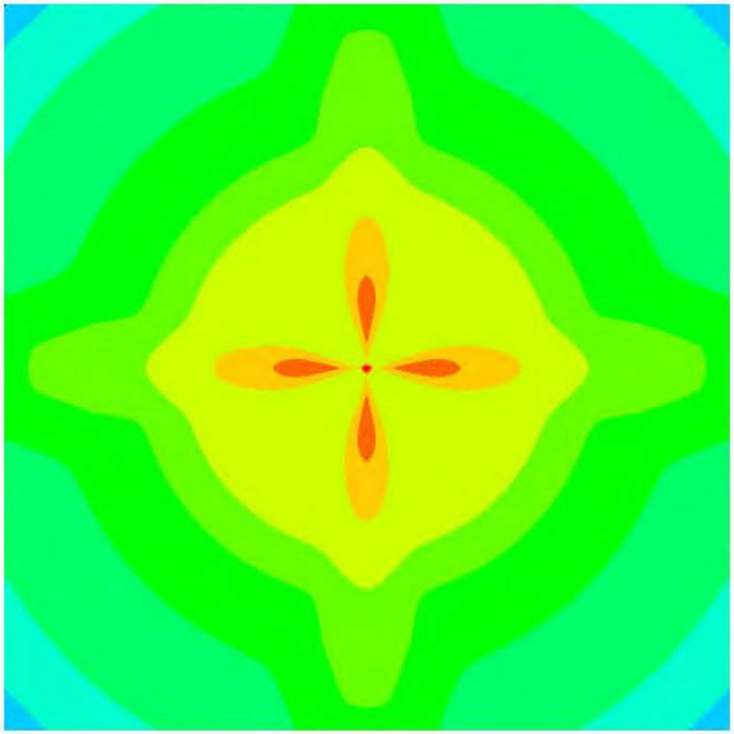
Kasun PES Model Comparison

Test 10 – 110.0 kg (242.508 lbs)

Kasun Model



Small RC Model



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Appendix VI-B

ACTA ANALYSIS

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Evaluation of HD 1.3 Tests Performed at China Lake

Prepared for: Dr. Josephine Covino, DDESB

Prepared by: ACTA Inc.

Dec 3, 2013

Outline

- Overview of current status of work performed
- Proposed process for evaluating HD 1.3 accidents
- Applying process for simulation of Test #4
- Conclusions

Status – ACTA's Evaluation of HD 1.3 Test Data

- ACTA received the hard disk containing all HD 1.3 test data from Kevin Ford
- Due to vacations & holidays, ACTA was only able to begin review of Test 4 data
- The objective of our current work was to develop a process for evaluating choked flow, the breakup of the PES, and the resulting debris throw (this work is still in progress).
- We applied our candidate process to Test 4 and made simplifying assumptions to simulate debris throw.
- Based on initial results, we believe the process can be implemented using a set of fast-running models
  – <u>More work is required to determine the best FRM's to implement</u>

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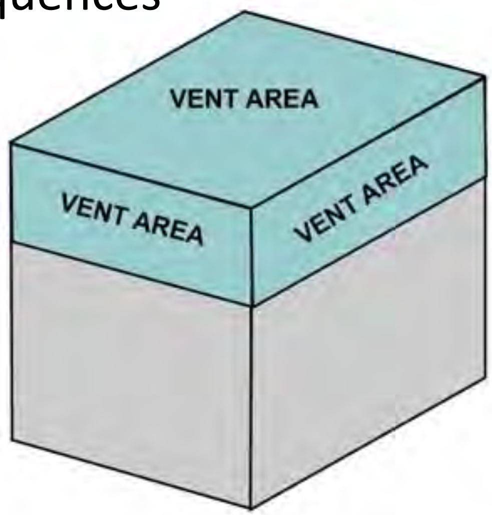
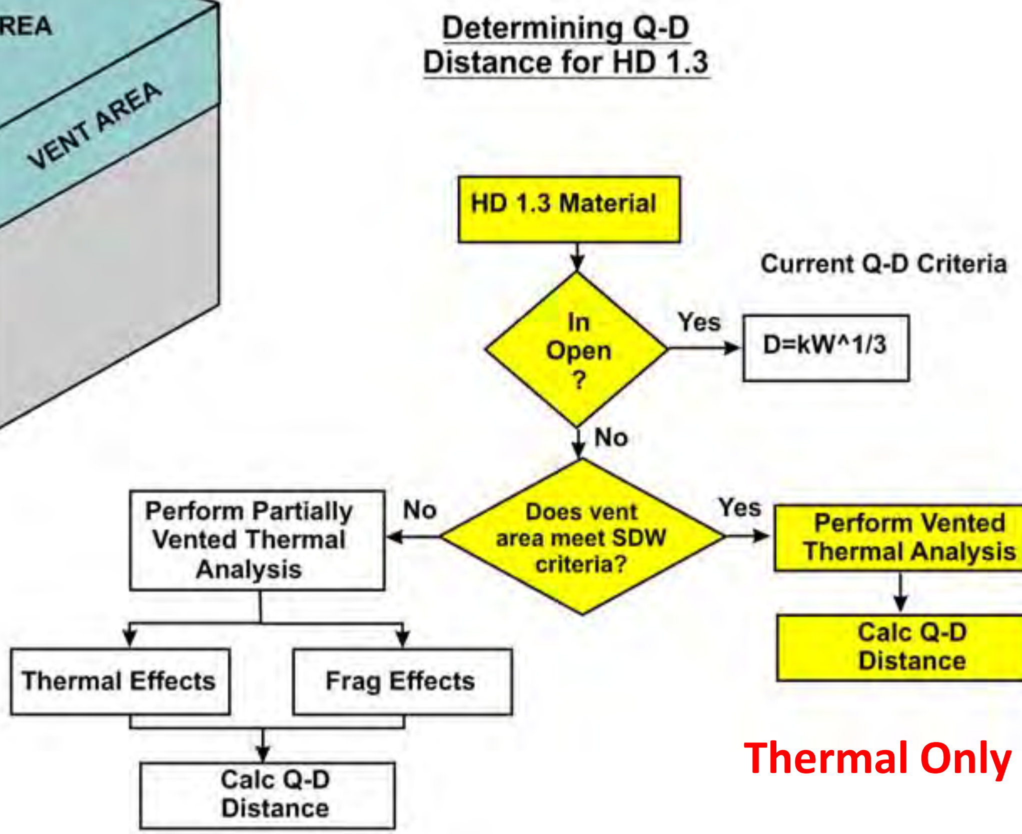
Using Fast-Running Models (FRMs) to Simulate Confined HD 1.3 Accidents

- ACTA drafted a White Paper (circa 2011) that put forward an approach for improving the consideration of HD 1.3 accidents that could lead to not only thermal but over-pressurization (air blast and fragmentation) consequences





Over-Pressurization & Thermal Branch

Thermal Only Branch

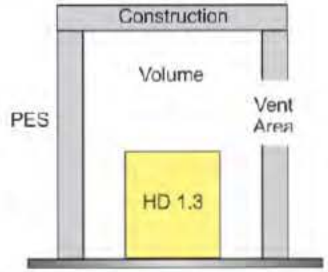
ACTA

Schematic of HD 1.2 Assessment Process

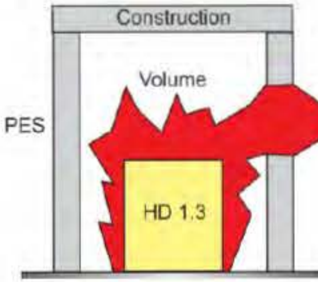
- Definition of problem
- Burning of HD 1.3 and determination of choked or unchoked flow
- If choked flow, calculate pressure build-up
- Compare internal pressure to PES failure criteria
- If PES fails, develop debris list
- Throw debris downrange to determine HFD & containment distances

How hard could this be ???

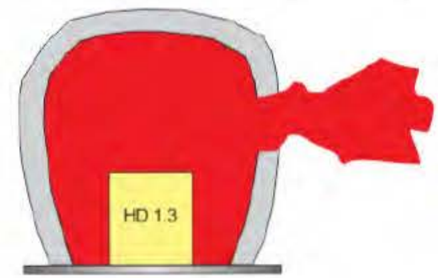
Model



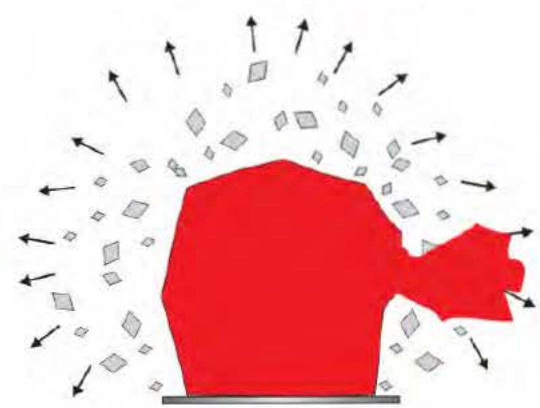
HD 1.3 Burning FRM



PES failure FRM



Debris generation & throw FRMs



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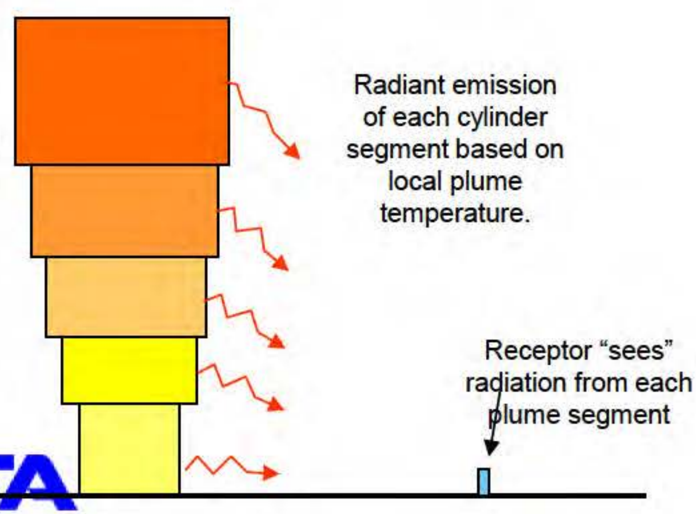
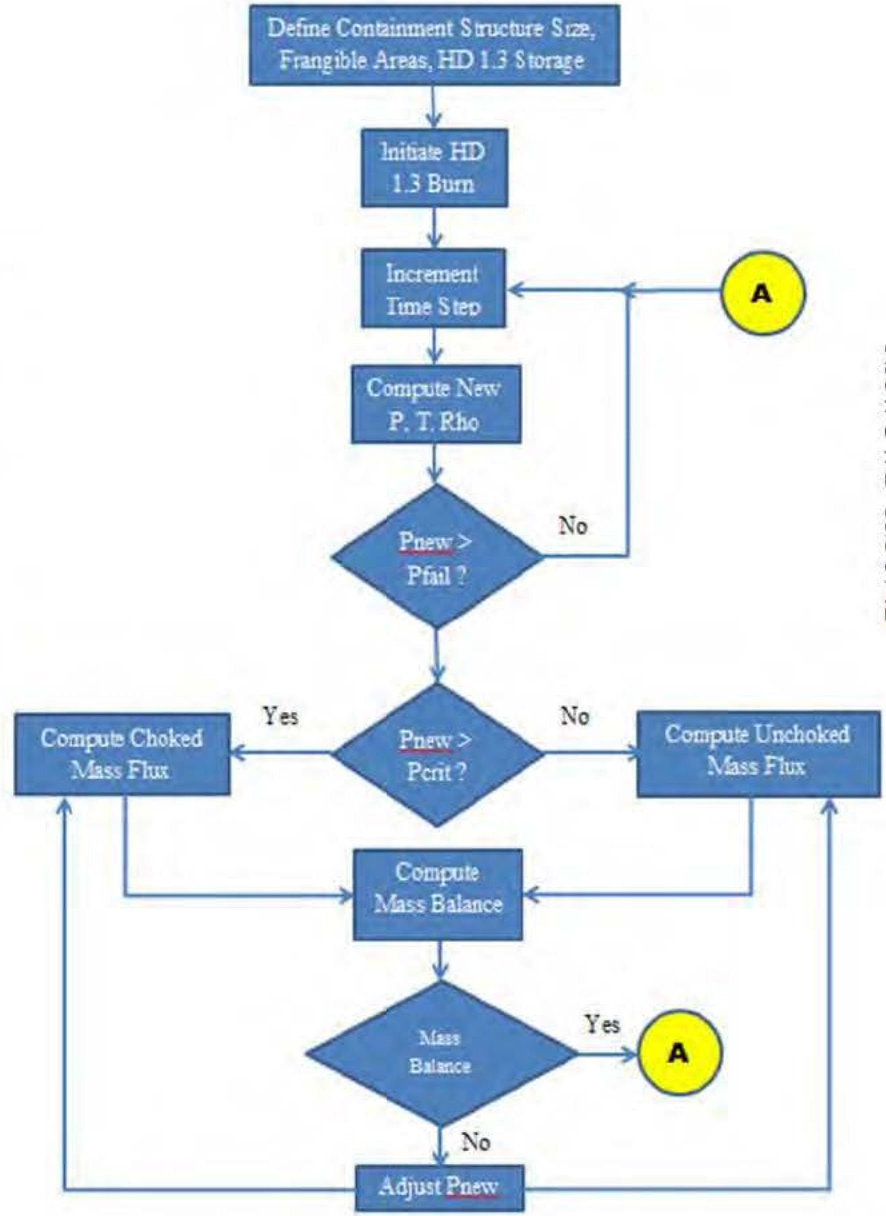
HD 1.3 Burn FRM

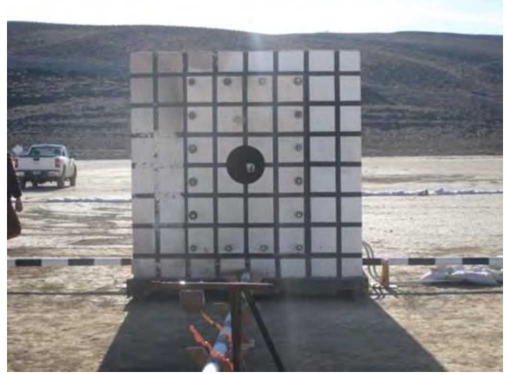
Ventrate Code Logic

- The proposed approach to evaluate the thermal radiation from the generated plume is to estimate the vertical height, size, shape and temperature of the plume
- Plume evolution is defined as a function of time using a fully-vetted AF model
- Accounts for entrainment of air into the plumes
  - This results in an increasing plume radius & decreasing plume temperature with height . Note that wind effect is another parameter that will tilt the plume



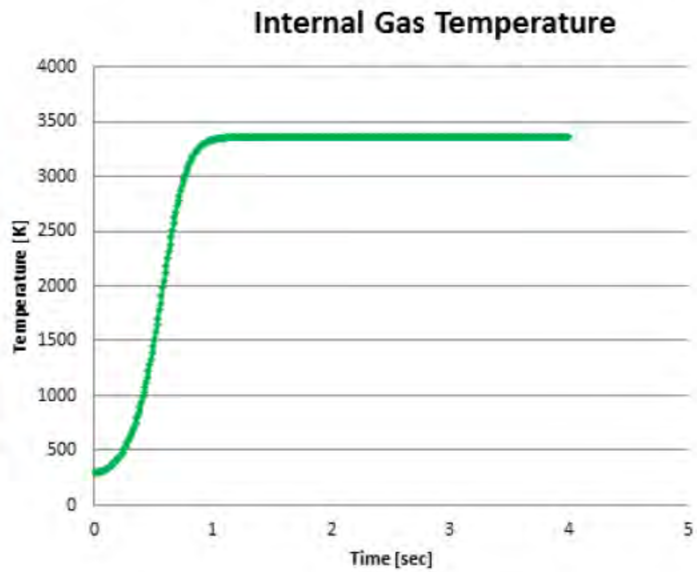


Test 4 Overview



- T-0.00 seconds — Electronic igniters activated
- T+0.92 seconds — Fire inside structure illuminates vent opening
- T+1.14 seconds — Flamelet out of opening
- T+1.30 seconds — Luminous flow out of opening
- T+1.41 seconds — Plume diameter > opening diameter, good plume
- T+1.89 seconds — Strong plume
- T+1.92 seconds — Roof of structure bulging
- T+1.96 seconds — Roof starting to fracture
- T+1.98 seconds — Huge fireball, roof coming apart
- T+2.03 seconds — Both roof and door/frame deflected to about 45 degrees
- T+2.04 seconds — Fireball rises well above structure, no plume
- T+2.11 seconds — Door almost vertical, fireball half roof and out north wall
- T+2.53 seconds — Roof about gone, lots of fragments, fireball building
- T+13.25 seconds — Few particles burning, few if any frags, fireball diminishing
- T+13.45 seconds — Fireball starting to diminish

Ventrate Simulation of Test 4



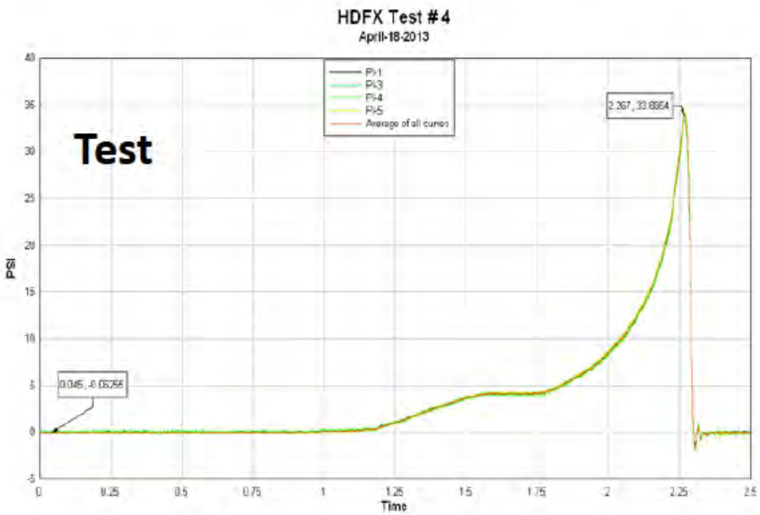


Figure 6-7. Interior Pressure Buildup in Test 4 with Structural Failure at T+2.267 Seconds at 33.885 PSIG.

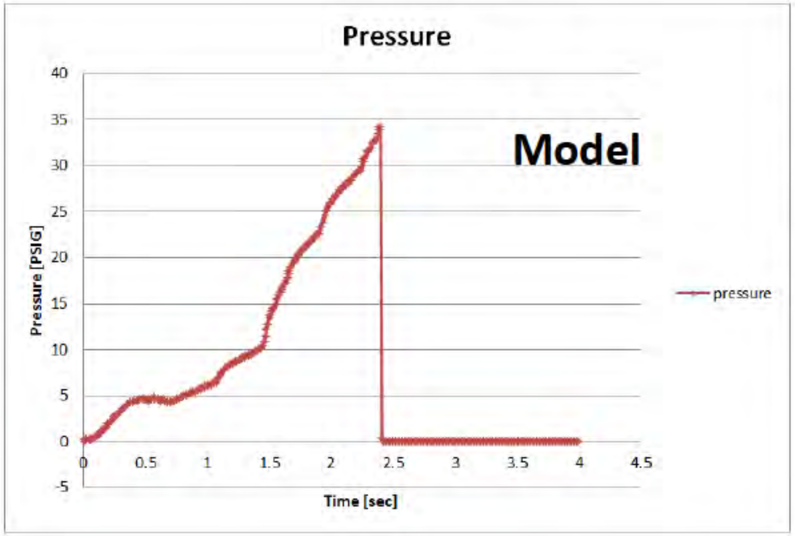
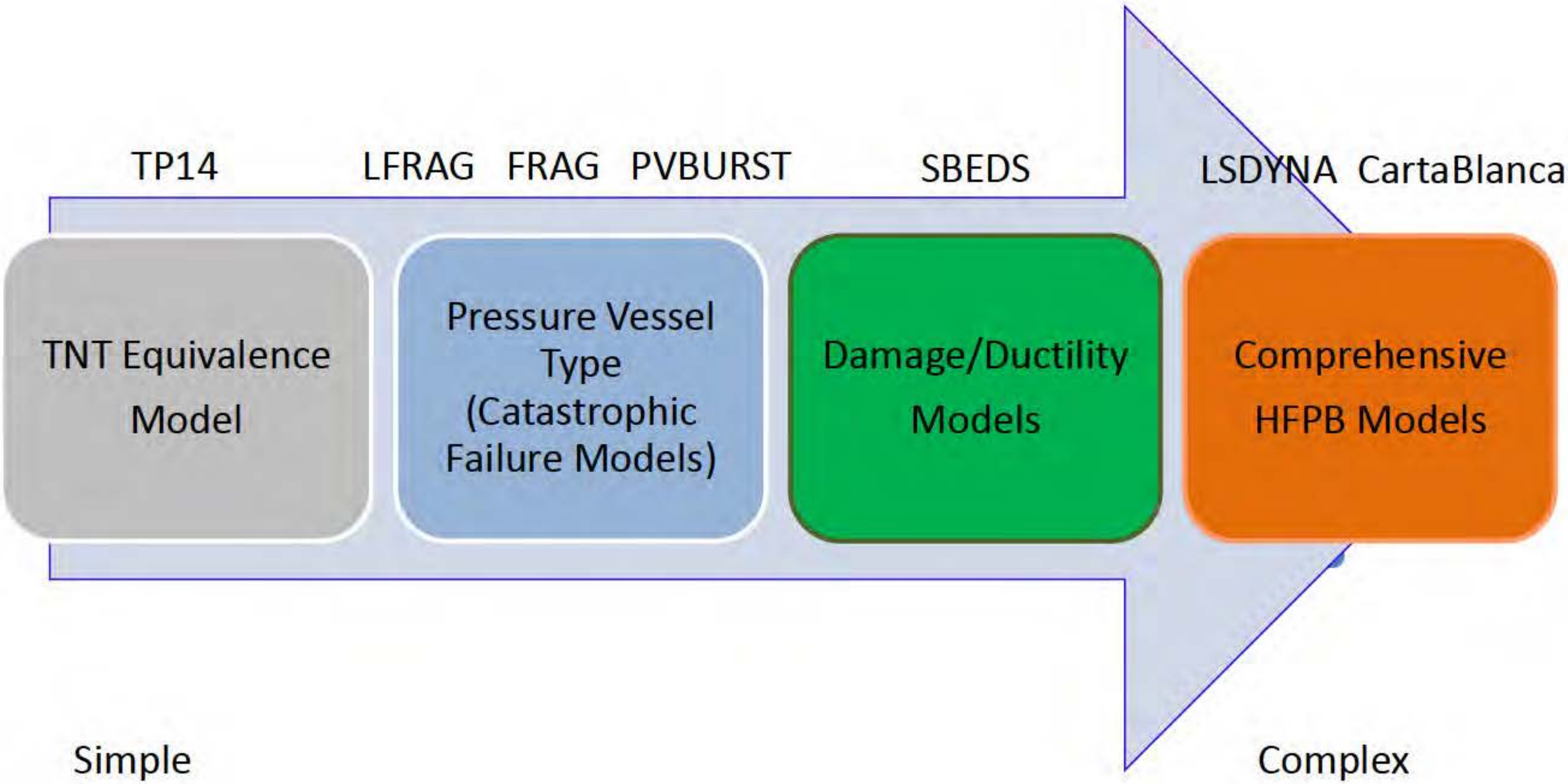


Figure 6-10. Venrate Predicted Pressure Time History for China Lake HD 1.3 Test 4

PES Failure & Debris Generation FRMs



PES Failure & Debris Generation FRM Options

- **TNT Equivalence**
  - Use TP14 methods to predict PES failure & debris list
- **Pressure Vessel Type Methods**
  - Assume catastrophic PES failure at some over-pressurization level
    - Will require offline work to develop failure FRMs as function of PES type and internal pressure
  - Develop debris list FRM offline
    - Could leverage AFRL internal explosion FRMs here
  - Use existing PV tools to predict debris velocities
    - AFRL FRMs, ACTA's LFRAG, FRAG, PVBURST codes
- **Damage/Ductility**
  - Apply pressure time history to SDOF type model to predict response (basically quasi-static)
  - Determine level of damage/failure based on ductility ratio (DR)
  - Using DR, develop debris list offline & estimate debris velocity as for PV's above or based on SDOF velocity associated w/ DR
- **High Fidelity Physics Based Models**
  - For different PES types/sizes/ construction make quasi-static internal pressure time history runs to predict failure criteria (as was done for AFRL)
  - Generate FRM from the various runs

Pressure Vessel Type Example

Kasun Debris Characterization using LFRAG

LFRAG* was developed to compute fragment data for debris risk analyses

Fragment Basic Characteristics:
- Fragment mass
- Rectangular dimensions
- Distance from center of explosion

Explosion Characteristics:
- Energy of explosion:
- Efficiency of energy transfer to kinetic energy

ACTA tool

LFRAG

Fragment Derived Characteristics:
- Imparted velocity distribution
- Ballistic coefficient distribution
- Lift-drag ratio
- Projected area

Energy of Explosion

$$E = \frac{PV}{\gamma - 1}$$

E : Energy of explosion
P : Pressure at burst
V : Chamber volume
$\gamma(T)$ Specific heat ratio as a function of temperature T

Model for Ballistic coefficient for cube shapes

$$\beta = \frac{W}{C_D A} \qquad C_D = 0.75$$

$$A = \frac{4}{\pi^2}\left(L_1 L_2 + L_1 L_3 + \frac{\pi}{2} L_2 L_3\right)$$

β : Ballistic coefficient
W : Fragment weight
C_D : Drag coefficient
A : Ballistic coefficient area
$L_1 = L_2 = L_3$: Cube edge

Model for 3-sigma Imparted Velocity

$$V_i = \sqrt{\frac{2 g \eta E A_i}{W_i R_i^3 \left(\sum_{j=1}^{n} \frac{A_j}{R_j^3}\right)}}$$

V_i : Imparted velocity
g : Gravity constant
η : Efficiency factor
R_i : Distance from kasun center
A_i : Projected area

* ACTA Report No. 11I-605/23.1-01

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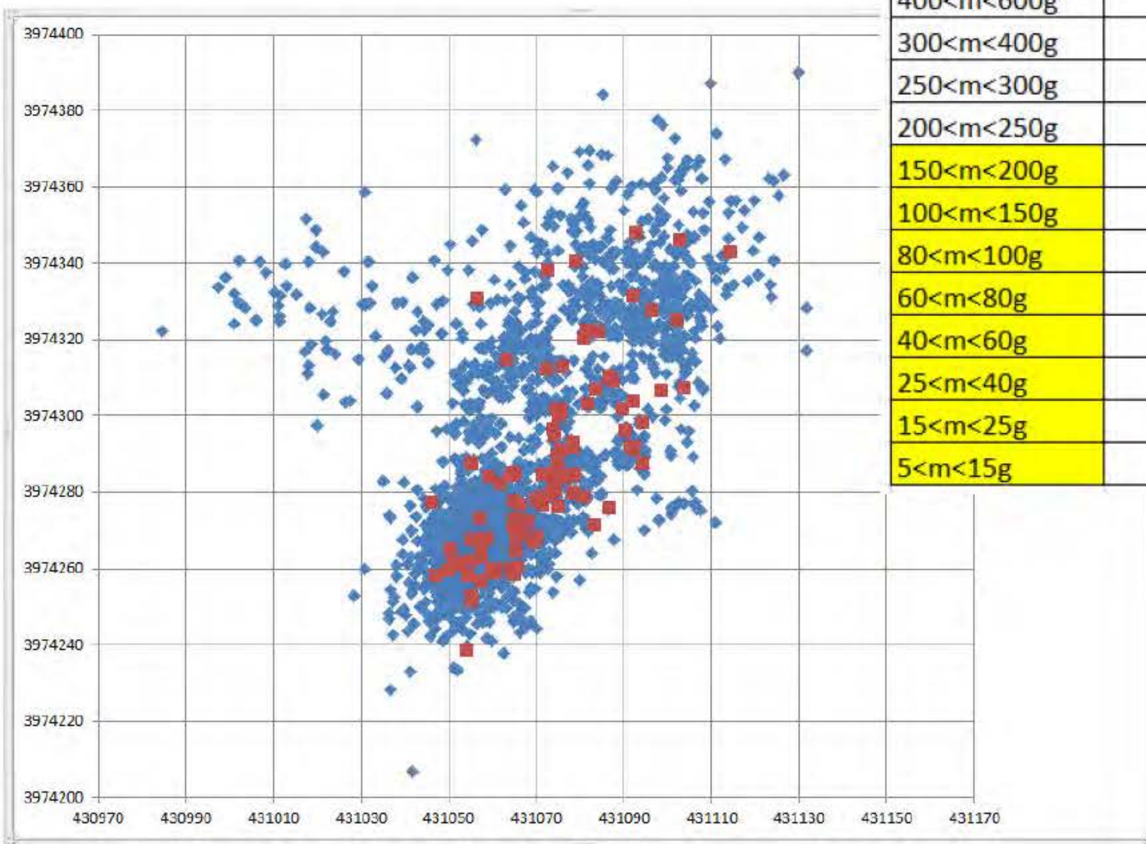
LFRAG Kasun Debris Model May be Improved

- **Limitations of current Kasun debris characterization:**
  - All fragments were treated as cubes
    - Test data further review may lead to dimension adjustments
  - Fragment takeoff directions were assumed to be hemi-spherically uniform
    - Could set up debris using wall/roof color codes
  - Imparted velocity model uses 1-D conservation relationships
    - No simulations were performed of fragment initial acceleration
    - Pressure energy based on approximation of specific heat ratio γ
      - Estimation $\gamma = 1.26$ may be improved based on measured temperature at time of kasun failure
  - All fragment distances from explosion center were kept constant
    - Used midpoint of box face to kasun center for all fragments
    - Can put in actual distances
- **The analysis methodology should be further developed**

Test #4 Pickup Data

- Individual fragment data were grouped into 23 mass bins
- These data were used as input to LFRAG

Mass Range	Number of Fragments	Mass of Fragments	Weight of Frags
>8000 g	1	8400	18.50
7000<m<8000g	3	21397.00	47.13
6000<m<7000g	1	6665.00	14.68
5000<m<6000g	4	22264.00	49.04
4000<m<5000g	6	26962.20	59.39
3000<m<4000g	5	16664.70	36.71
2000<m<3000g	25	60686.70	133.67
1500<m<2000g	33	58339.70	128.50
1000<m<1500g	69	83886.50	184.77
800<m<1000g	46	41026.30	90.37
600<m<800g	66	46113.10	101.57
400<m<600g	98	48077.40	105.90
300<m<400g	114	38961.00	85.82
250<m<300g	79	21328.30	46.98
200<m<250g	98	21981.20	48.42
150<m<200g	105	18104.40	39.88
100<m<150g	150	18565.70	40.89
80<m<100g	66	6003.60	13.22
60<m<80g	122	8380.00	18.46
40<m<60g	165	8132.50	17.91
25<m<40g	226	6991.30	15.40
15<m<25g	303	5833.90	12.85
5<m<15g	763	7026.40	15.48



Generating Test #4 Fragment List using LFRAG

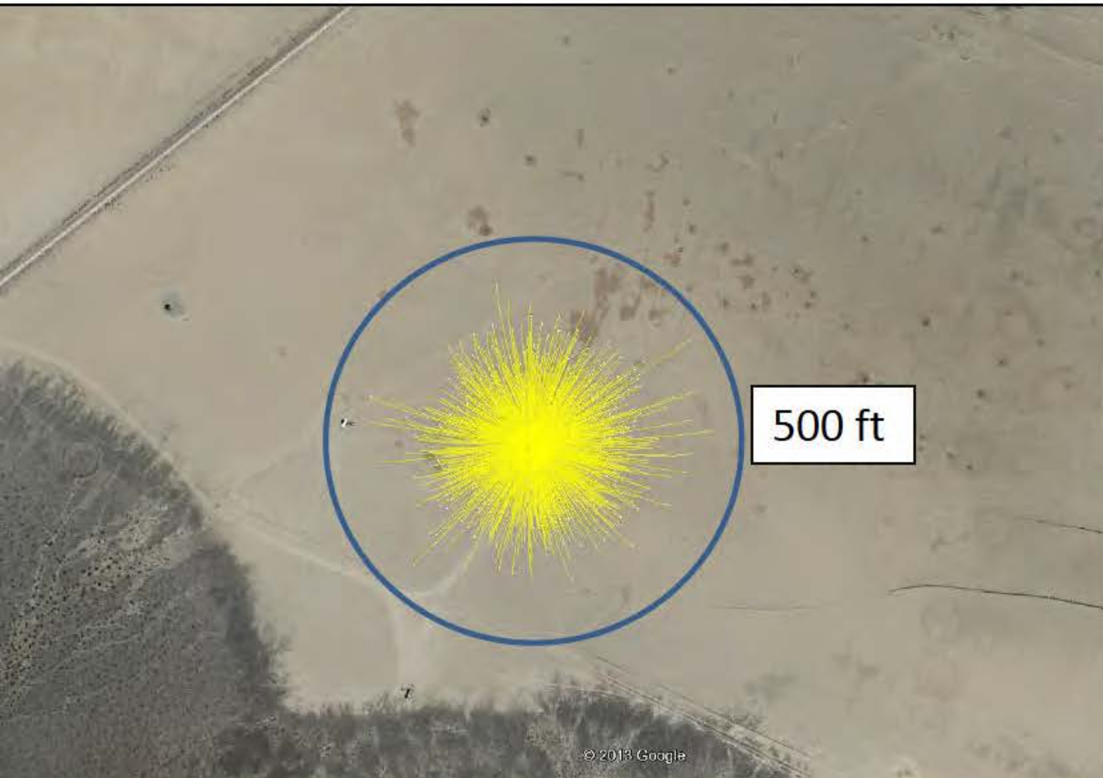
- The 23 mass bins were input to LFRAG:
  - The energy of the over-pressurization was computed and used to calculate the takeoff velocities based on the area of the fragments (assumed to be cubes), their distance from the center of the Kasun (assumed to be the same for all fragments) and the efficiency factor of the process
  - The efficiency factor was varied until fragment velocities were obtained that could throw fragments to the distances recorded during the test
  - ACTA uses efficiency factors of 1-5% for spacecraft type explosions; to match Test #4 throw distances efficiency factors from 15-20% are required

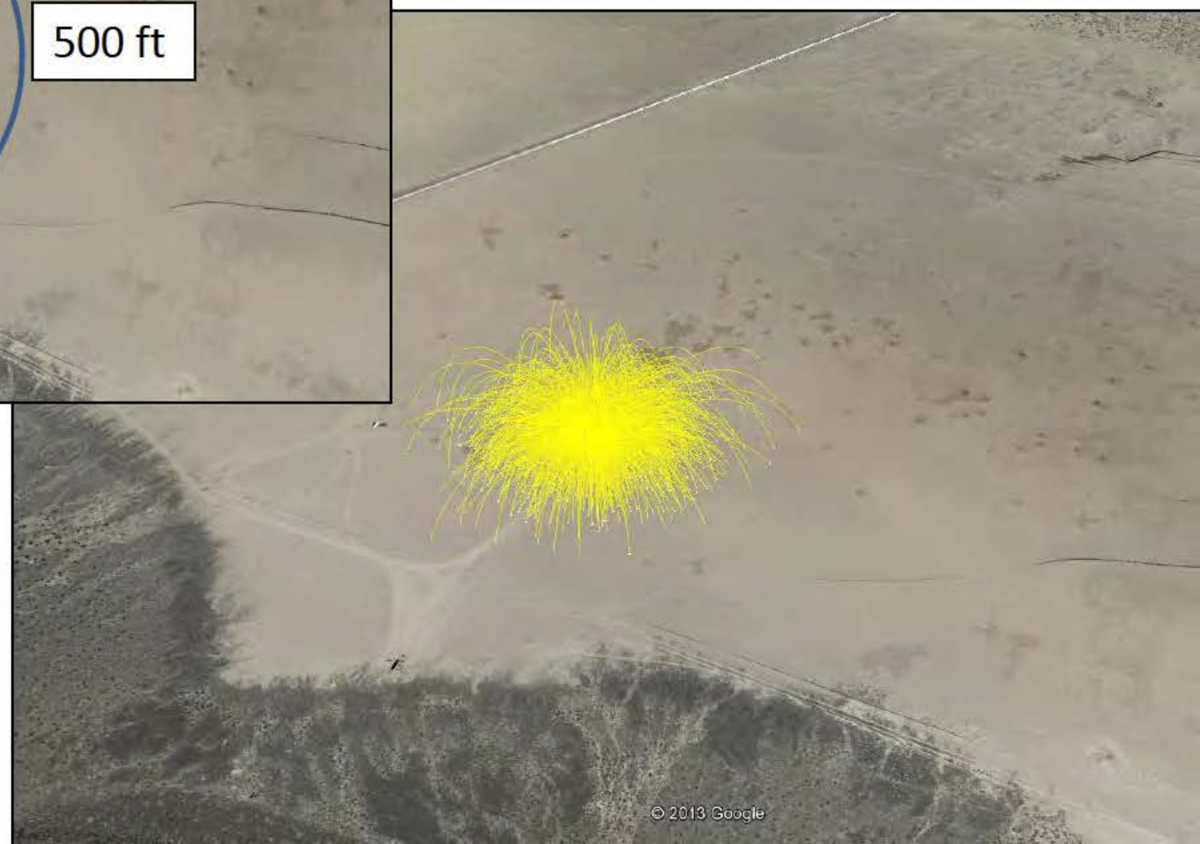
95 – 300 ft/sec

		Bin Mass Low (grams)	Bin Mass High (grams)	Bin Mass Low (lbs)	Bin Mass High (lbs)	Mass of Fragments (gms)	Weight of Fragments (lbs)	Number of Fragments	LFRAG Velocity (ft/sec)	TRAJ_CAN Max Dist (ft)	ID	NAME	NOTES	X	Y
1	>8000 g	8000	10000	17.621	22.026	8400	18.50	1	94.5	250	1	house	sw	431081.4614	3974296
2	7000<m<8000g	7000	8000	15.419	17.621	21397.00	47.13	3	97.1	260	2	house	se	431083.7350	3974295
3	6000<m<7000g	6000	7000	13.216	15.419	6665.00	14.68	1	98.3	263	1	house	ne	431085.0916	3974297
4	5000<m<6000g	5000	6000	11.013	13.216	22264.00	49.04	4	100.8	272	0	House	nw	431083.0233	3974298
5	4000<m<5000g	4000	5000	8.811	11.013	26962.20	59.39	6	104.5		1	gauge	1	431086.3771	3974301
6	3000<m<4000g	3000	4000	6.608	8.811	16664.70	36.71	5	110.5	310	2	gauge	2	431089.0808	3974306
7	2000<m<3000g	2000	3000	4.405	6.608	60686.70	133.67	25	115.6		3	gauge	3	431093.3897	3974314
8	1500<m<2000g	1500	2000	3.304	4.405	58339.70	128.50	33	122.3	350	4	gauge	4	431107.6940	3974340
9	1000<m<1500g	1000	1500	2.203	3.304	83886.50	184.77	69	130.2		5	gauge	5	431133.1740	3974385
10	800<m<1000g	800	1000	1.762	2.203	41026.30	90.37	46	137	389	7	gauge	7	431081.3668	3974323
11	600<m<800g	600	800	1.322	1.762	46113.10	101.57	66	142.9		8	gauge	8	431076.5545	3974314
12	400<m<600g	400	600	0.881	1.322	48077.40	105.90	98	151.6	414	9	gauge	9	431074.0046	3974310
13	300<m<400g	300	400	0.661	0.881	38961.00	85.82	114	161.2		9	gauge	9	431065.4712	3974315
14	250<m<300g	250	300	0.551	0.661	21328.30	46.98	79	166.7	428	10	gauge	10	431067.9955	3974319
15	200<m<250g	200	250	0.441	0.551	21981.20	48.42	98	173.4		11	gauge	11	431098.0390	3974292
16	150<m<200g	150	200	0.330	0.441	18104.40	39.88	105	180.5	430	12	gauge	12	431101.5393	3974295
17	100<m<150g	100	150	0.220	0.330	18565.70	40.89	150	191.5		12	gauge	12	431107.3485	3974304
18	80<m<100g	80	100	0.176	0.220	6003.60	13.22	66	200.9		13	gauge	13	431109.5980	3974289
19	60<m<80g	60	80	0.132	0.176	8380.00	18.46	122	211.3	421	14	gauge	14	431105.5838	3974286
20	40<m<60g	40	60	0.088	0.132	8132.50	17.91	165	220.9		15	gauge	15	431083.1024	3974274
21	25<m<40g	25	40	0.055	0.088	6991.30	15.40	226	240	394	1	camera	1	431059.2375	3974287
22	15<m<25g	15	25	0.033	0.055	5833.90	12.85	303	261						
23	5<m<15g	5	15	0.011	0.033	7026.40	15.48	763	296.9	341					
						601,791	1,326	2,548							

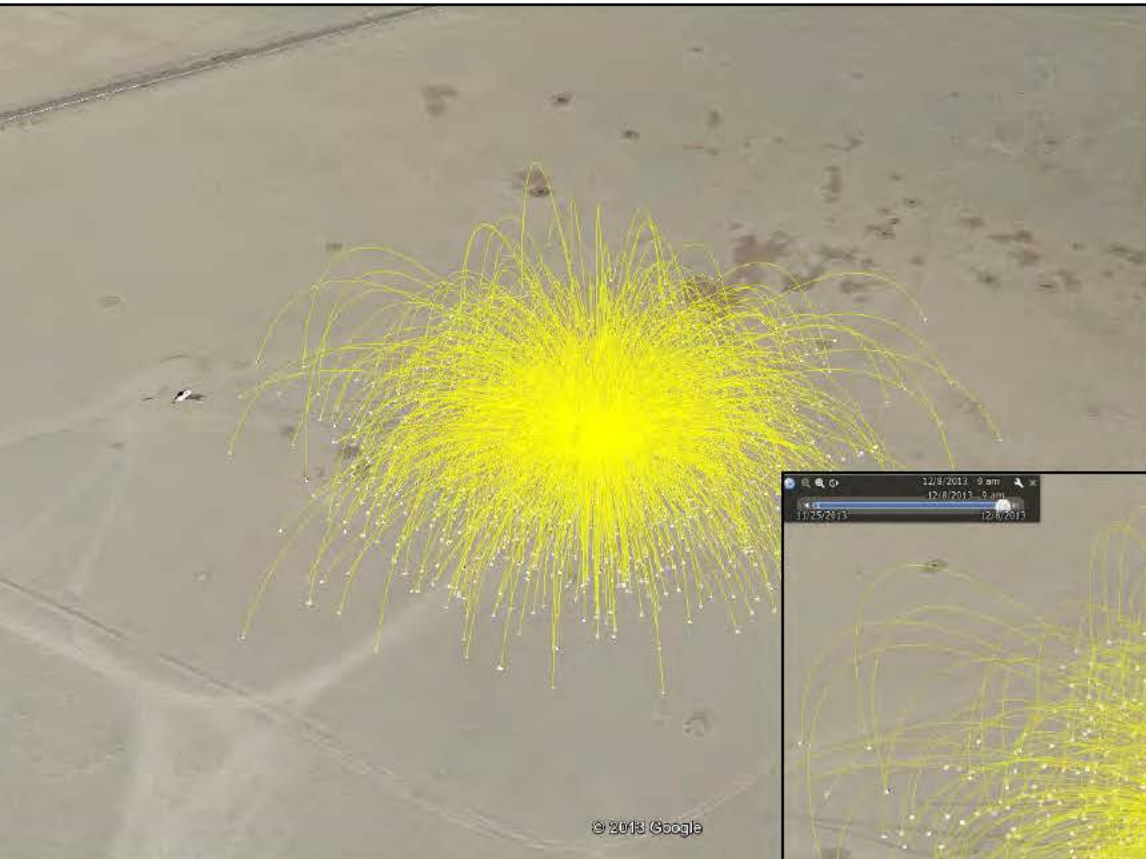
Note: TRAJ_CAN distances are based on concrete tumbling cube drag coeff & reference area

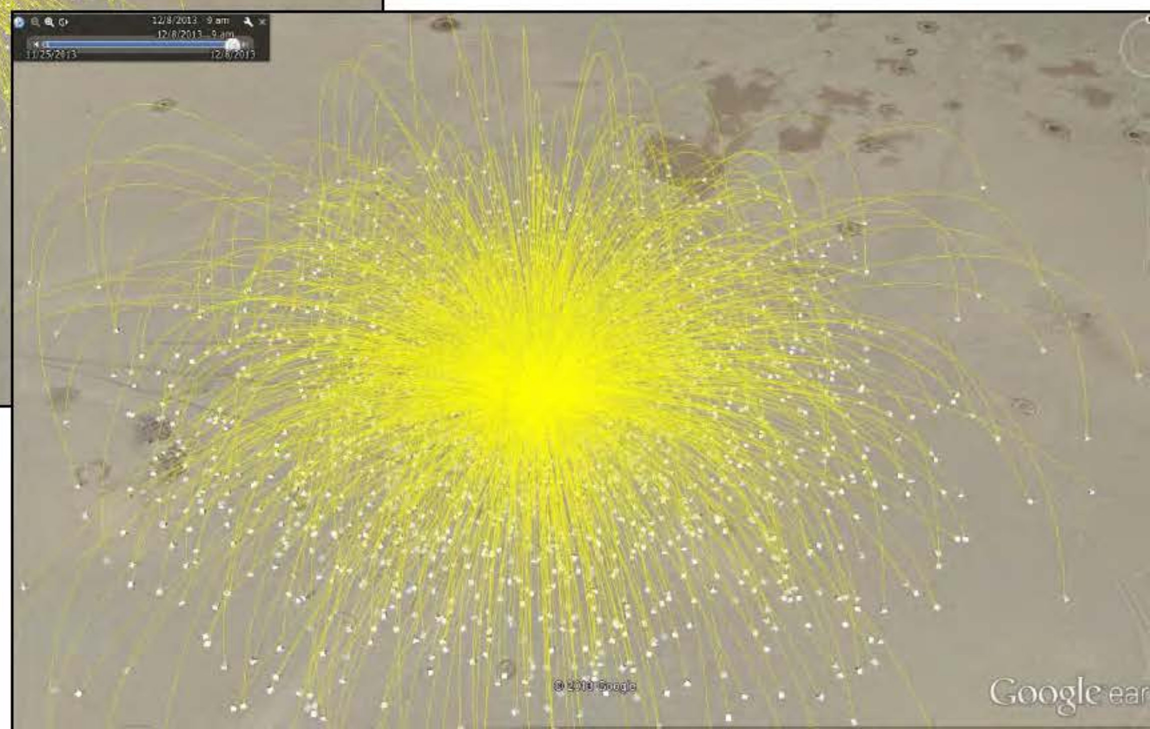
Simulation of Test #4





Simulation of Test #4





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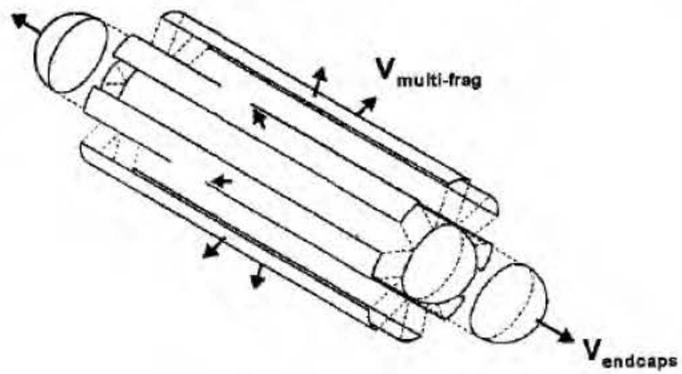
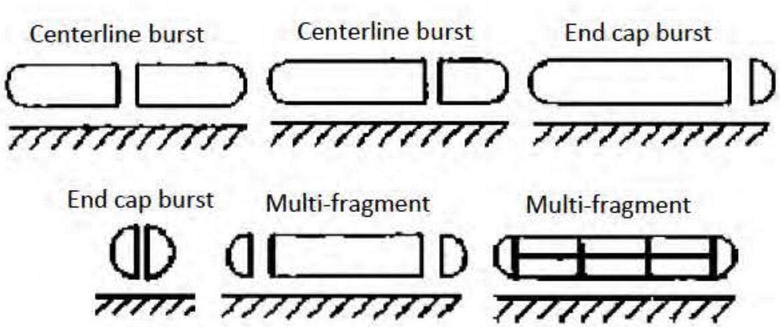
Pressure Vessel Type Example

Kasun Debris Characterization using PVBURST

- PVBURST was developed to simulate explosions of cylindrical and spherical pressure vessels and estimated maximum fragment velocity



- Several breakup configurations are available for PVBURST



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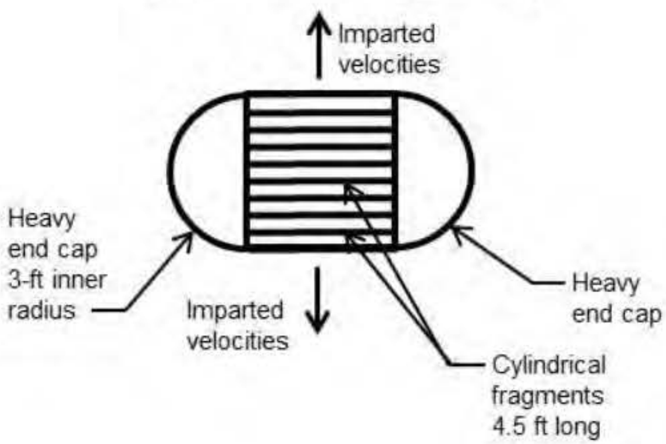
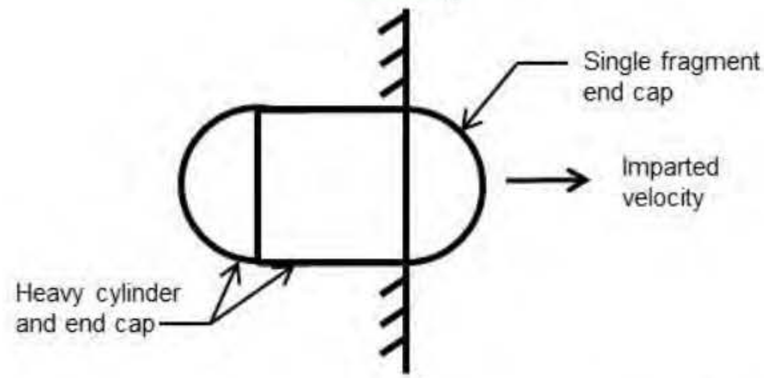
Pressure Vessel Type Example

Kasun Debris Characterization using PVBURST

2 pressure vessel burst configurations were investigated





Velocities are in right ball park

PVBURST inputs and results

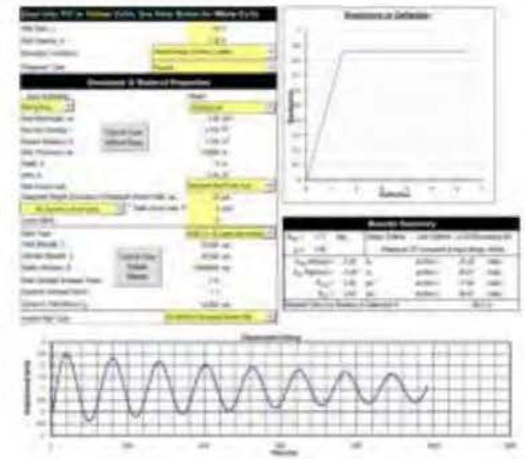
Configuration	Chamber Volume ft3	Chamber Gas	Concrete Thickness ft	Total Fragment Weight lb	Number of Fragments	Individual Fragment Weight lb	Imparted Velocity fps	**Max Dist (ft)**
Fracturing Cylinder	242	CO_2	0.10	1294	70	18.5	**139**	**475**
End Cap	242	CO_2	0.14	1244	1	1244	**95**	**270**

Damage/Ductility Example

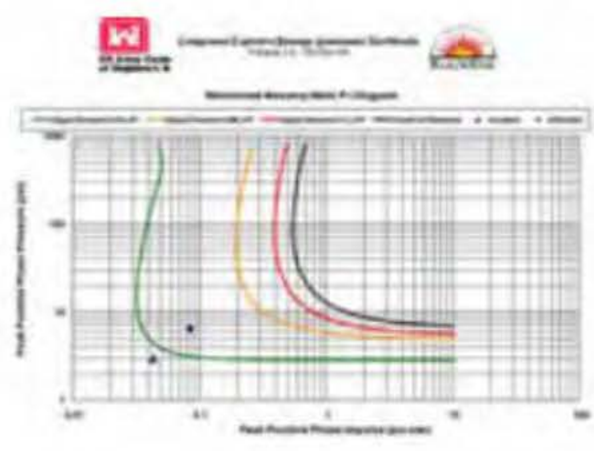
Kasun Debris Characterization using SBEDS

- Since our primary concern is gas pressure buildup, our current thinking is that it would be relatively simple to run simple quasi-static wall response analyses using existing SDOF codes (e.g., SBEDS)
- The wall response would be translated into a ductility level and the ductility level into a damage level.
- Then, given the damage level we would use engineering judgment and/or AFRL results and relevant test data to estimate the debris that would be thrown (mass and takeoff velocity/angle distributions)
- This approach is cost efficient and there are no potential pitfalls.
- Issue – need to develop fragment list

SBEDS



CEDAW



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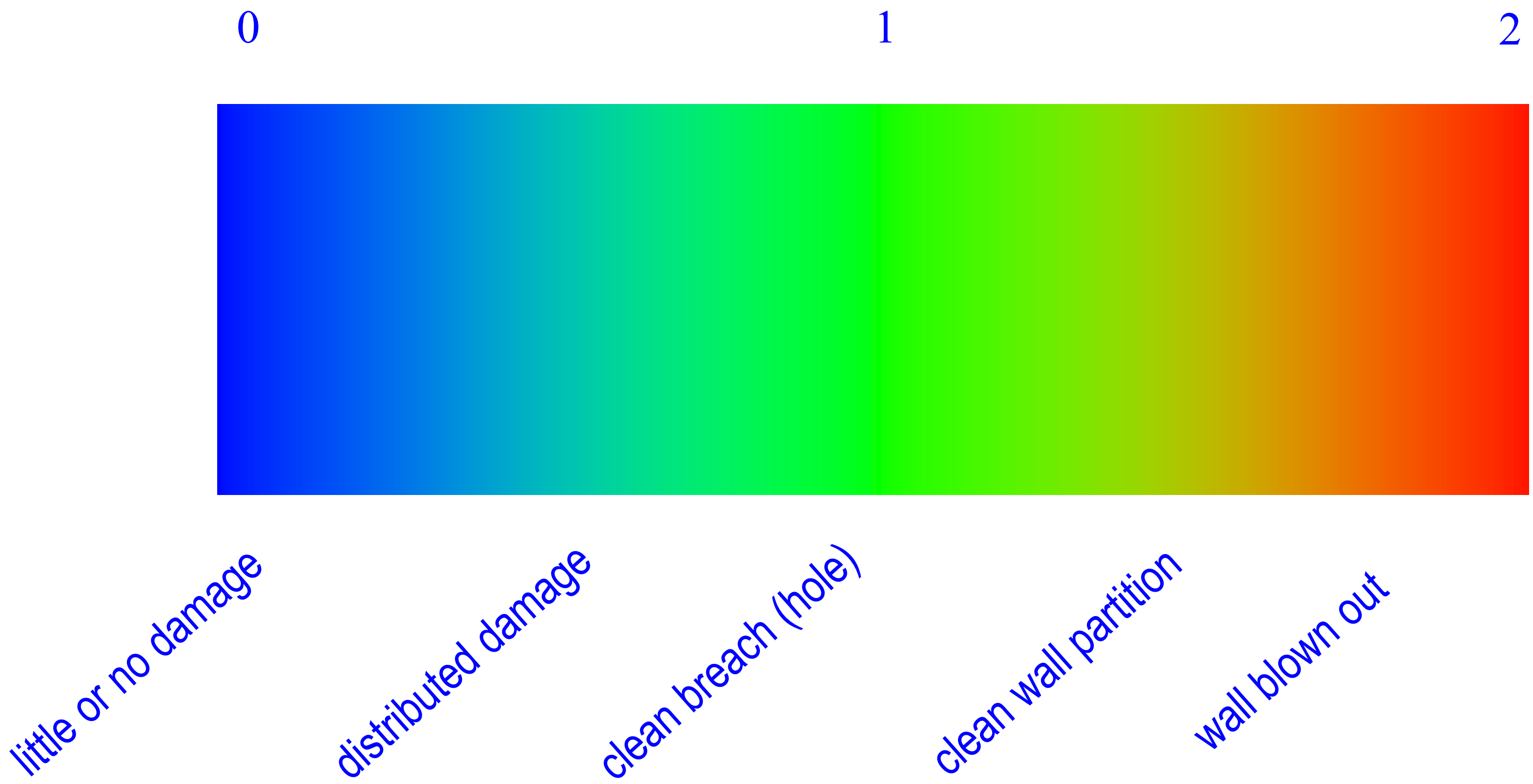
High Fidelity Physics Based Example

Kasun Debris Characterization using LSDYNA

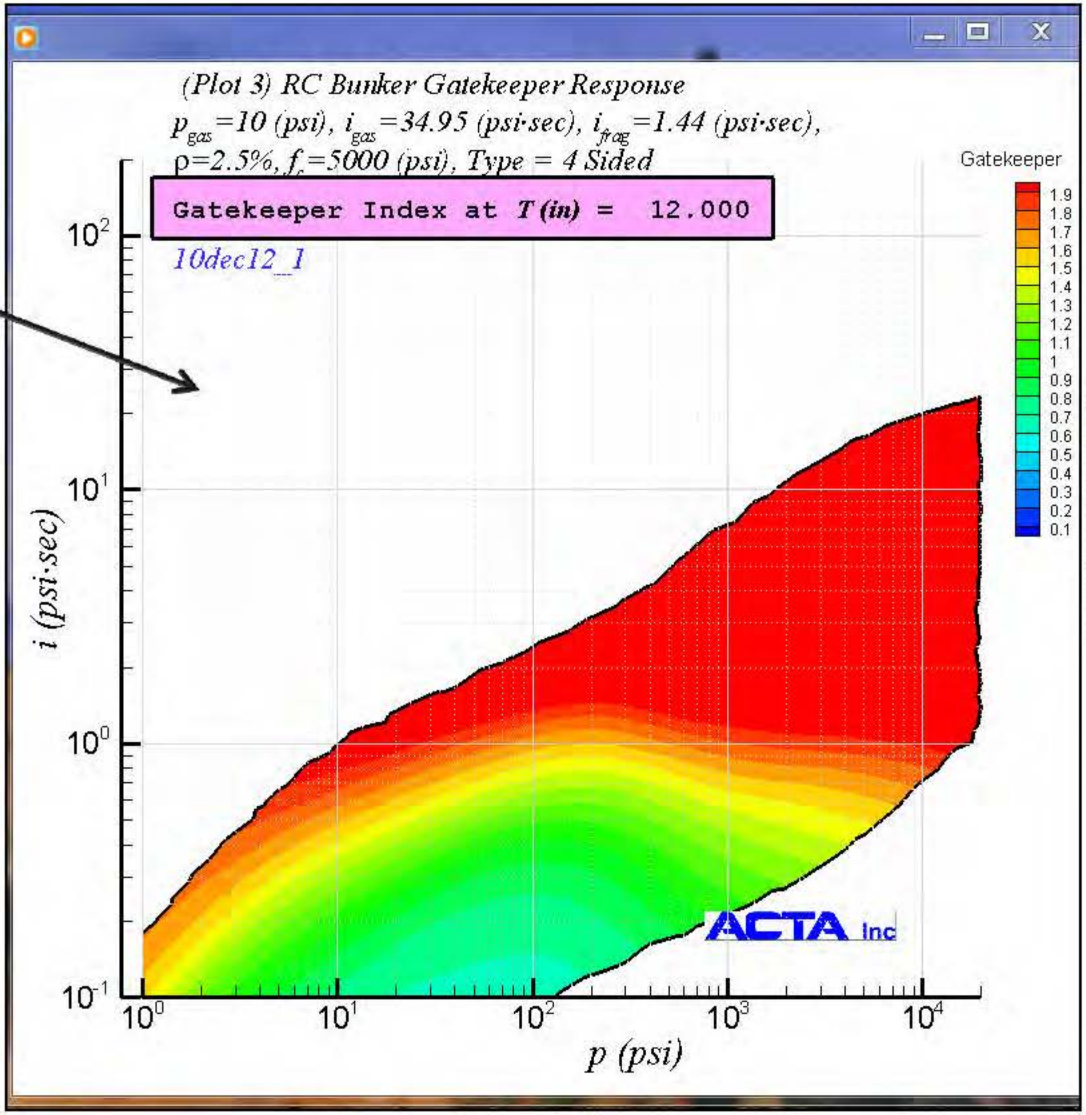
- ACTA/K&C have been working for several years on developing FRM's for AFRL to predict the level of wall damage and resultant debris throw for a cased weapon explosion inside a donor room
  - The wall loading model considers air shock, primary fragment impact, and gas pressure buildup.
  - Detailed LS-DYNA runs were made to cover a range of expected parametric variations over:
    - Weapon Type
    - Wall Type – RC, CMU, Brick, Adobe, etc.
    - Wall Characteristics (thickness, aspect ratio, rebar, strengths, etc.)
  - The results from the LS-DYNA runs were used to generate a fast-running model of wall response, damage level and resulting debris
  - The following slides show a few examples
- Our initial goal is to see if we can leverage these FRMs to predict wall damage and debris throw for the HD 1.3 tests.
- Issue – will the current FRMs adequately model the effects of gas pressure only

AFRL Structural Damage Indicator



Structural Damage Indicator (SDI)

- Movie shows how the SDI varies as a function of the RC wall thickness
  - Figure is for a 12” thickness
- Results are for the detonation of a cased weapon in the center of a donor room
- Underlying RC FRM considers:
  - Wall aspect ratio, strength, boundary conditions
  - Peak air blast pressure & impulse
  - Fragment impulse loading
  - Peak gas pressure & impulse



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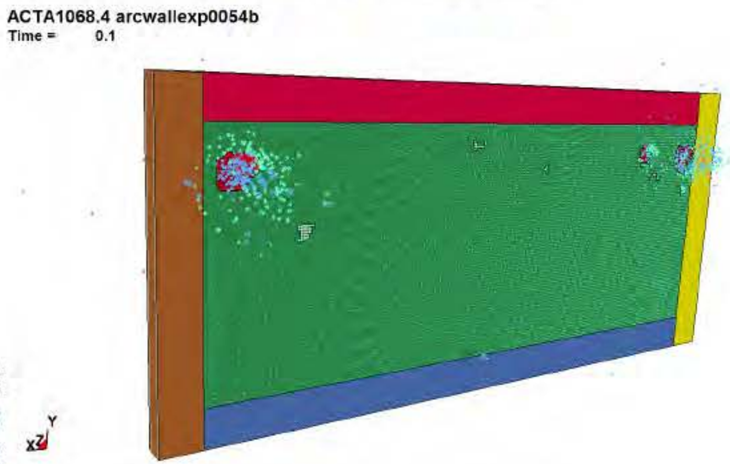
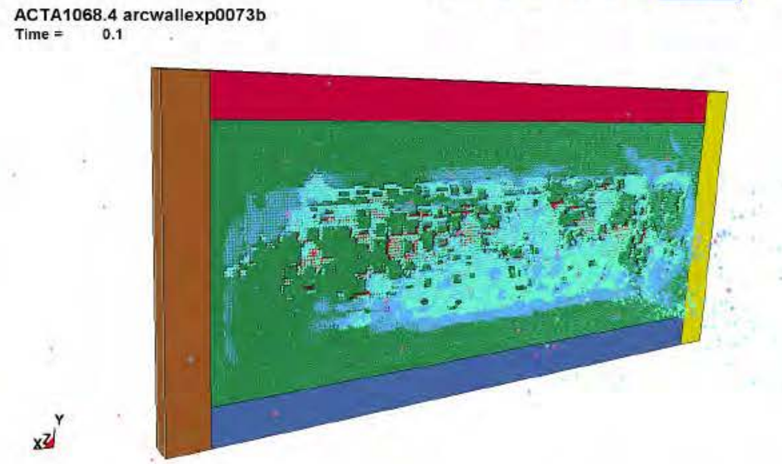
Low Values of Structural Damage Indicator

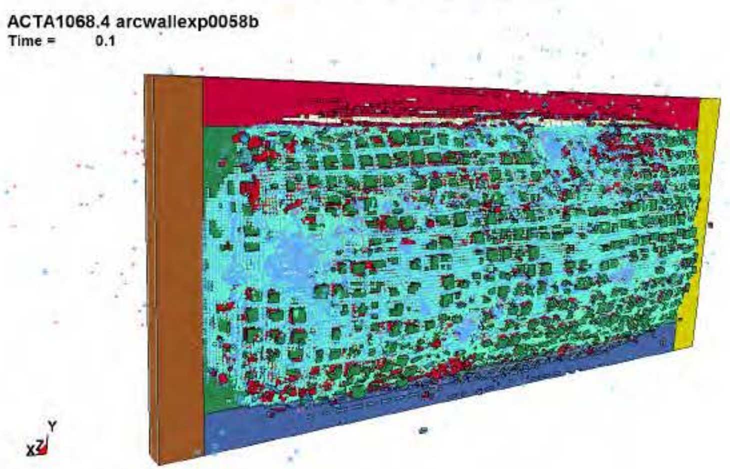
Case 54: 0.05



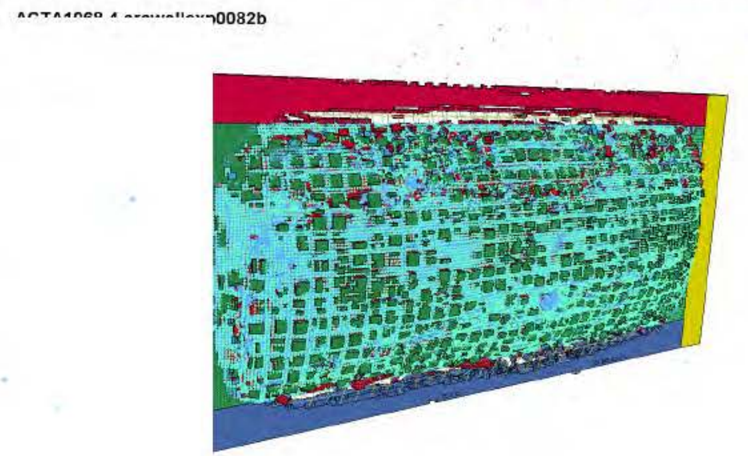
Case 73: 0.3



Case 58: 0.65



Case 82: 0.65



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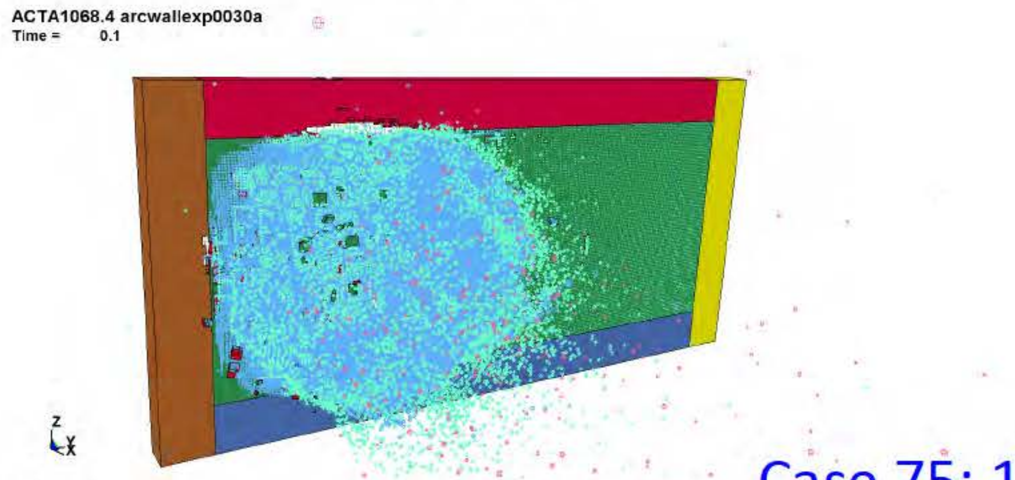
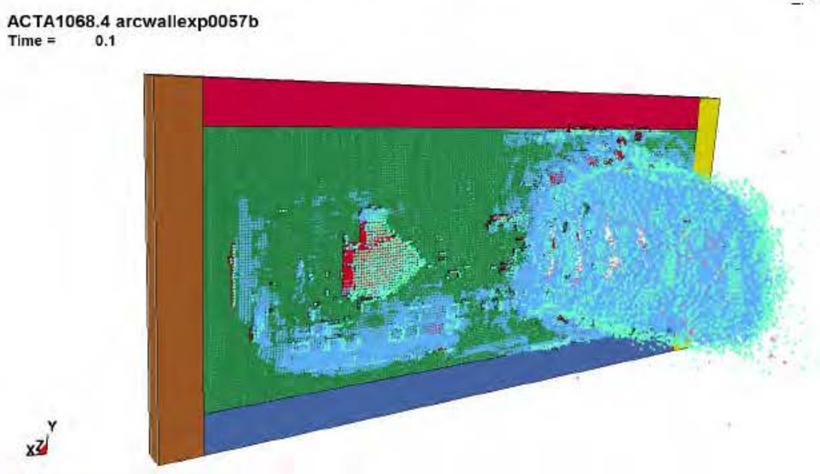
Critical Values of Structural Damage Indicator

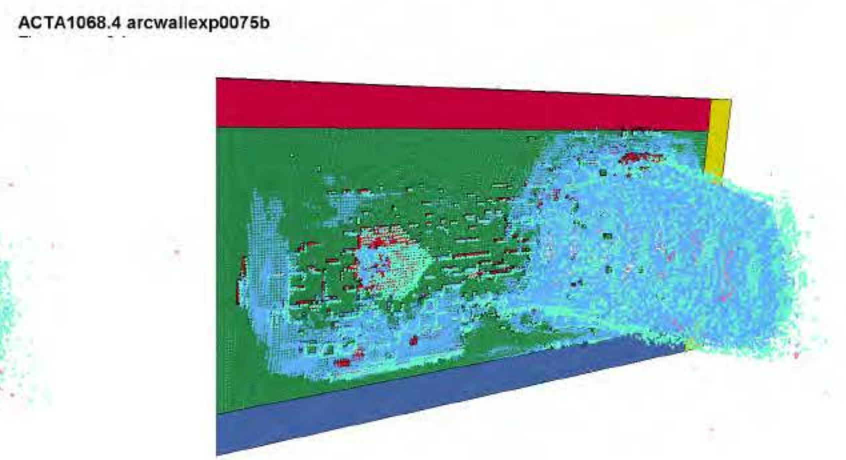
Case 30: <u>1.0</u>



Case 57: <u>0.95</u>

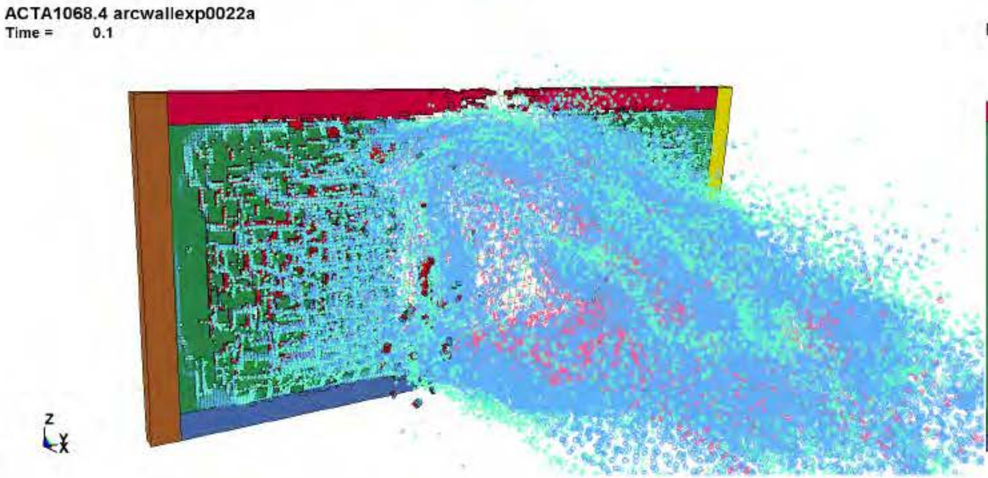


Case 75: <u>1.0</u>

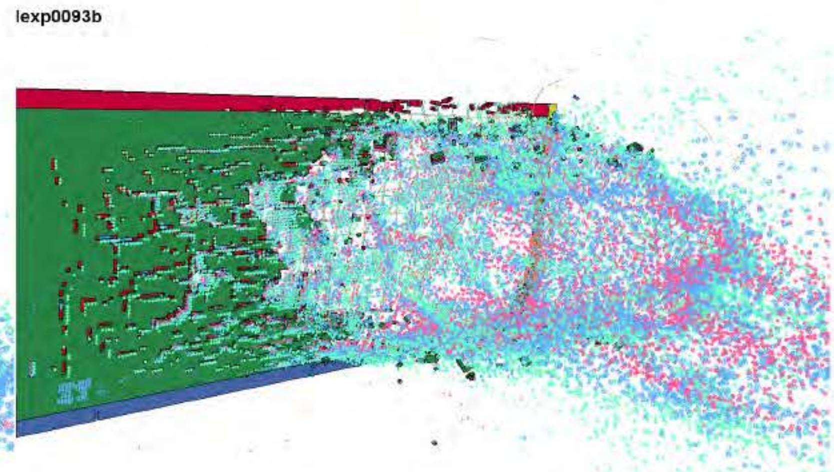


Highest Values of Structural Damage Indicator

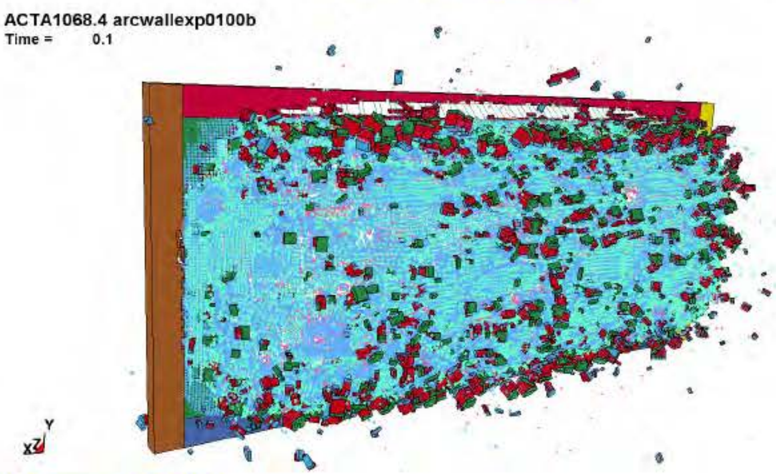
Case 22: 1.3



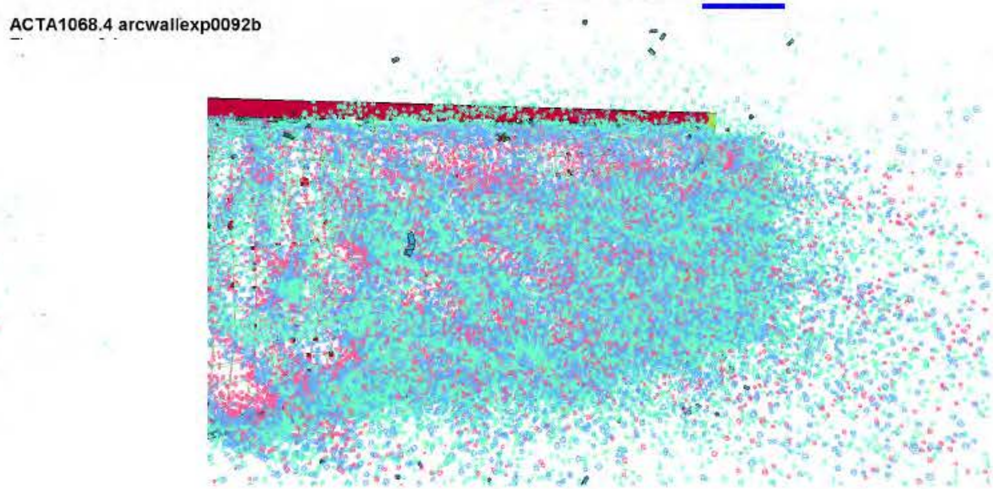
Case 93: 1.35



Case 100: 1.7



Case 92: 1.9



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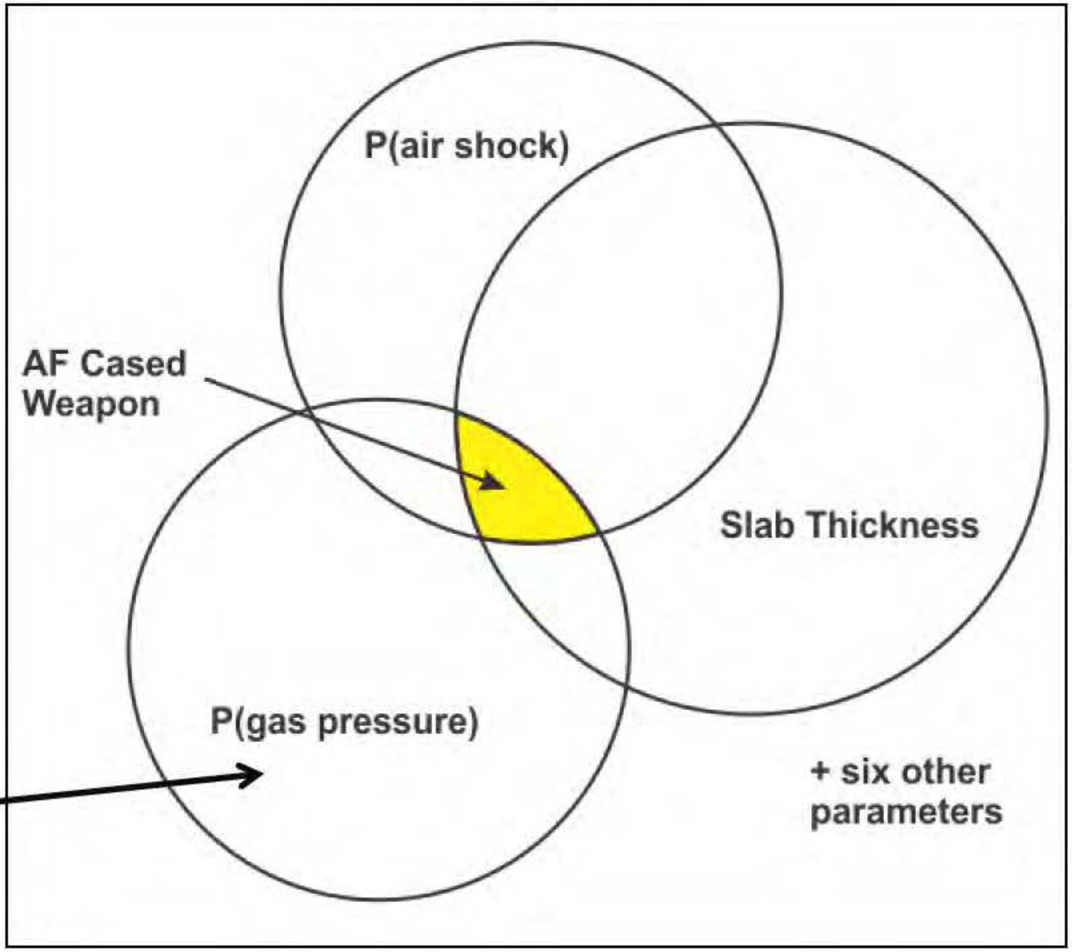
Understanding AFRL FRMs

- AFRL FRMs determine response, damage & debris due to an internal detonation of a cased weapon inside a donor room
- Hundreds of LS-DYNA runs were made to cover the "union" of nine parameters
  - Shock pressure, gas pressure and fragmentation loading on walls were considered
  - RC, CMU, Brick, Adobe wall construction were run
- For our "gas pressure" only application we would need to make additional runs to cover our range of PES and loading parameters

Venn Diagram



Conclusions

- To develop safe separation distances, HD 1.3 methods should consider:
  - Thermal only effects (un-choked flow)
  - Thermal + Over-pressurization effects (choked flow)
- ACTA's Ventrate application is able to simulate Test 4 gas pressure build-up
  - Included burn rate, structure volume & vent area parameters
  - Need to get thermal attenuation with distance test data for vertical plume radiation and attenuation comparisons (ACTA has tools for this)
- Four methods were presented for evaluation; all have their positives and negatives
  - All involved some type of FRM
  - More complex methods include better consideration of HD 1.3 physics but are more difficult to develop
  - Simpler methods are easier to develop/use but don't model all HD 1.3 physics
- What is the best path forward ?
  - We would recommend that the results of simpler FRM methods be compared w/ the more complex HFPB/FRM methods before making a decision.
    - TNT equivalency models could be exercised parametrically to determine the appropriate Yield Factor for HD 1.3 ?
    - We have demonstrated use of LFRAG and PVBURST for Kasun Test 4
    - Recommend completing work on SDOF Damage/Ductility approach
    - NEXC has detailed LS-DYNA model of Kasun that can be used to make parametric runs of wall/roof response, structural damage indices and ACTA can translate to FRM

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